Textile Texts

FIRST EDITION
1901

PRESENTED BY
THE DRAPER COMPANY
HOPEDALE, MASS.

Property of C Chilson
54 Freedom St Hopedale

To Our Customers,

The Cotton Manufacturers of the United States,

WHOSE ENTERPRISE IN

TESTING AND ADOPTING VALUABLE IMPROVEMENTS IN MACHINERY HAS STIMULATED THE DEVELOPMENT OF IMPORTANT INVENTIONS, THUS IMPROVING THE QUALITY AND DIMINISHING THE COST OF THE FABRICS PRODUCED,

THIS OUR NINTH DESCRIPTIVE CATALOGUE,

Is Respectfully Dedicated.

Illustration showing our works in process of reorganization during the fall of 1900. Present enlargements will carry our building operations well into 1902. This view is taken from the back and can only give a vague idea of the general plan.

TEXTILE TEXTS

FOR

COTTON MANUFACTURERS,

CONCERNING THE

PROPER METHODS OF EQUIPPING AND RUNNING MILLS,

INCLUDING SPECIAL TREATISES ON

CARDING, SPINNING, SPOOLING,
WARPING, DYEING, REELING,
TWISTING AND WEAVING.

ALSO

GENERAL HISTORY, MATHEMATICAL TABLES,

AND A FULL LIST OF THE

PATENTED COTTON MACHINERY,

INTRODUCED AND SOLD BY

THE DRAPER COMPANY.

AS THIS WORK MAY BE REVISED MORE OR LESS WITHIN THE NEXT FEW YEARS, IT WILL BE KNOWN IN THE PRESENT FORM AS THE . .

FIRST, OR 1901 EDITION.

PRESENTED WITH THEIR COMPLIMENTS.

HOPEDALE, MASS., U. S. A.
1901.

Copyright 1901,
BY THE DRAPER COMPANY.

Written and Compiled by
GEORGE OTIS DRAPER.

DATES OF ISSUE OF GEO. DRAPER & SONS' CATALOGUES.

1st—1871—50 pages.
2d—1872—66 pages.
3d—1873—75 pages.
4th—1876—66 pages.
5th—1881—126 pages.
6th—1887—214 pages.
7th—1893—80 pages. (No advertising, mostly tables.)
8th—1896—272 pages.

DATES OF ISSUE OF THE DRAPER COMPANY COMPLETE CATALOGUES.

1st (corresponding to 9th)—1901—320 pages.

Printed by
COOK & SONS, MILFORD, MASS.

PREFACE.

The business now under control of The DRAPER COMPANY, a corporation organized under the laws of the state of Maine in 1896, was taken over from former Hopedale Corporations and firms, on January first, 1897. The original industry was established early in the century, the following chronological table showing the gradual changes:

1816—IRA DRAPER. Starts taking out loom patents.

1830—JAMES DRAPER, (son of Ira) purchases loom and temple business.

1837—JAMES and E. D. DRAPER form partnership.

1839.—Important patent on temple improvement granted to GEORGE DRAPER.

1842—Transfer of E. D. DRAPER'S business to Hopedale, Mass.

1852—E. D. AND G. DRAPER form partnership, selling Temples, Let-off Motions, etc.

1856—HOPEDALE MACHINE CO. organized.

1856—Dutcher temples first made in Hopedale by W. W. Dutcher.

1867—HOPEDALE MACHINE COMPANY chartered.

1867—DUTCHER TEMPLE COMPANY chartered.

1867—HOPEDALE FURNACE COMPANY chartered.

1868—Partnership of GEO. DRAPER & SON replaces that of E. D. and G. DRAPER, E. D. Draper retiring in favor of Wm. F. Draper, first son of George Draper.

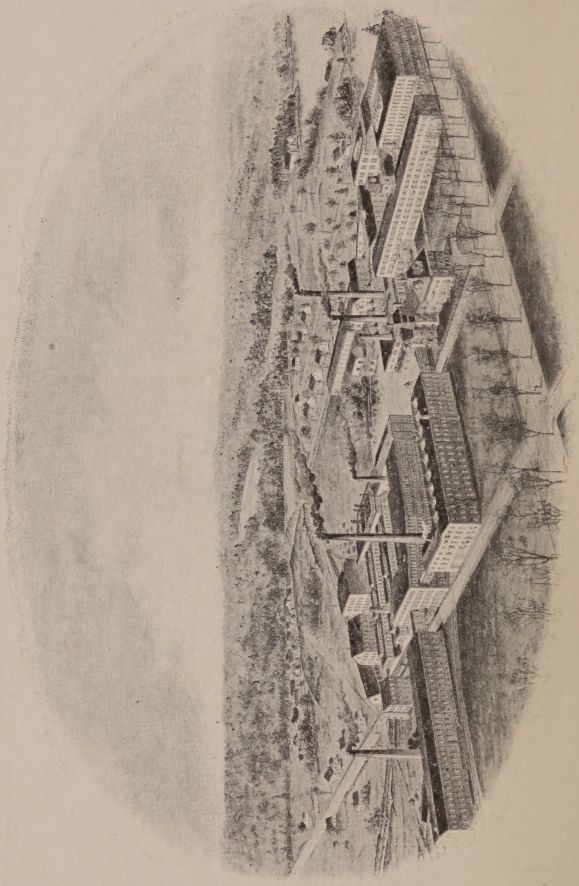
1877—Partnership name changed to GEO. DRAPER & SONS, on admission of Geo. A. Draper, second son of George Draper.

1880—Eben S. Draper, third son of George, admitted to GEO. DRAPER & SONS.

1880—Consolidation of HOPEDALE FURNACE COMPANY with HOPEDALE MACHINE COMPANY. Large additions in progress.

1886.—Incorporation of the town of HOPEDALE as distinct from the town of MILFORD of which it was formerly a part.

1887—Wm. F. Draper, Jr., first son of Wm. F. Draper, admitted to GEO. DRAPER & SONS. Death of George Draper occurs same year. Firm name unchanged.



WORKS AS IN 1899 BEFORE LATEST ALTERATIONS WERE STARTED.

1888—Hopedale Machine Screw Company chartered.

1899—George Otis Draper, second son of Wm. F. Draper, admitted to Geo. Draper & Sons.

1892—Northrop Loom Company chartered.

1897—Draper Company absorbs,
George Draper & Sons,
The Hopedale Machine Company,
The Dutcher Temple Company,
The Hopedale Machine Screw Company,
and takes over the United States rights of the Northrop Loom Company and the agency for the Sawyer Spindle Company.

1898—Plant of the Hopedale Elastic Goods Company purchased by the Draper Company, for necessary enlargement of business.

1899—Start on plan of alteration to double total output.

1900—The Draper Company takes rank as the largest American producer of cotton machinery, with the largest plant and the largest number of operatives.

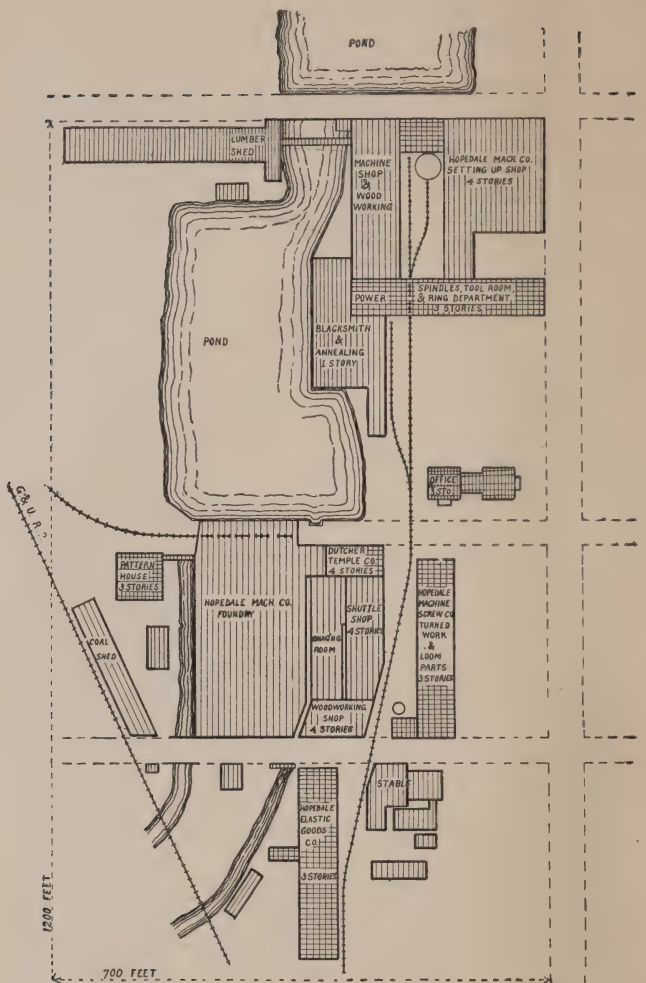
1901—Organization of the Draper Company at start of new century comprises the following officers:—
William F. Draper, President.
Joseph B. Bancroft, Vice-President.
George A. Draper, Treasurer.
Eben S. Draper, Agent.
George Otis Draper, Secretary.
E. D. Bancroft, Purchasing Agent.
Frank J. Dutcher, Assistant Agent.
Chas. M. Day, General Superintendent.
Directors—William F. Draper, Joseph B. Bancroft, Geo. A. Draper, Eben S. Draper, George Otis Draper, E. D. Bancroft, Frank J. Dutcher, Charles M. Day, C. H. Draper.

TOWN OF HOPEDALE, MASS. IN 1899.

OUR LOCATION.

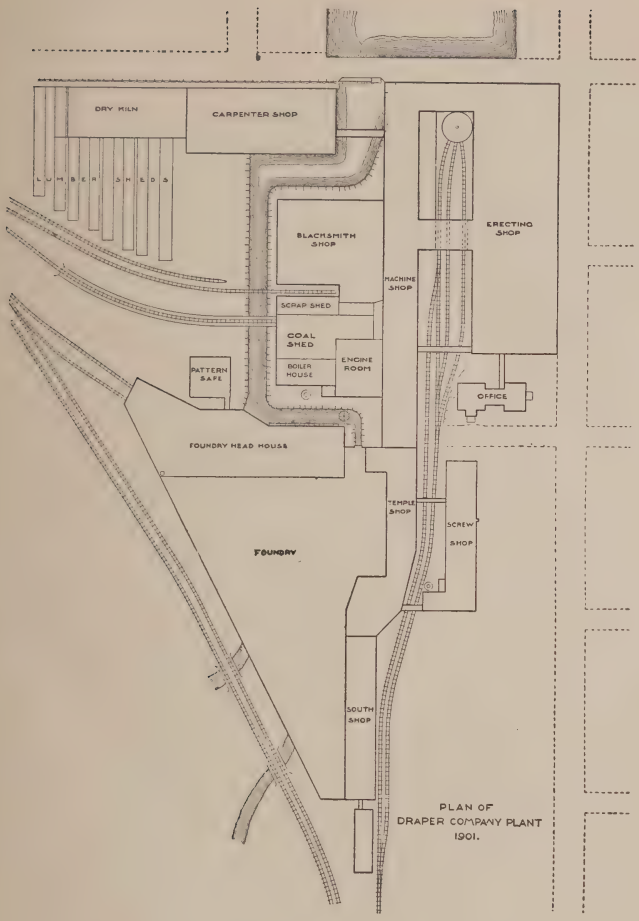
As shown on the opposite page, our works are situated in the country village of Hopedale, Mass., adjoining the large town of Milford, of which we were formerly a part. A straight line between Boston and New York would bisect us at a point about thirty miles from the former city. While off of the main line of railroad we have branch connections to Boston from Milford via South Framingham on the Boston & Albany route and via Franklin to Boston on the N. Y., N. H. & H. route. The Grafton & Upton R. R. connects Hopedale with Worcester (19 miles), through North Grafton on the B. & A. Providence (26 miles) connections are made either through Franklin by the N. Y., N. H. & H. route or by Woonsocket via Bellingham Junction on the Boston and Pascoag route. Trolley cars passing our office run directly to South Framingham (13 miles) and connect at Milford, with trolley lines to Woonsocket (13 miles), Franklin (10 miles), Medway (7 miles,) and points beyond. Trolley line from Hopedale to Uxbridge (8 miles) on the Providence and Worcester division of the N. Y., N. H. & H. road now building.

Telegrams are telephoned to us from the Milford office of the Western Union Co. If addressed to Hopedale they will reach us properly. Our long distance telephone call is Milford 26-13 and 12.



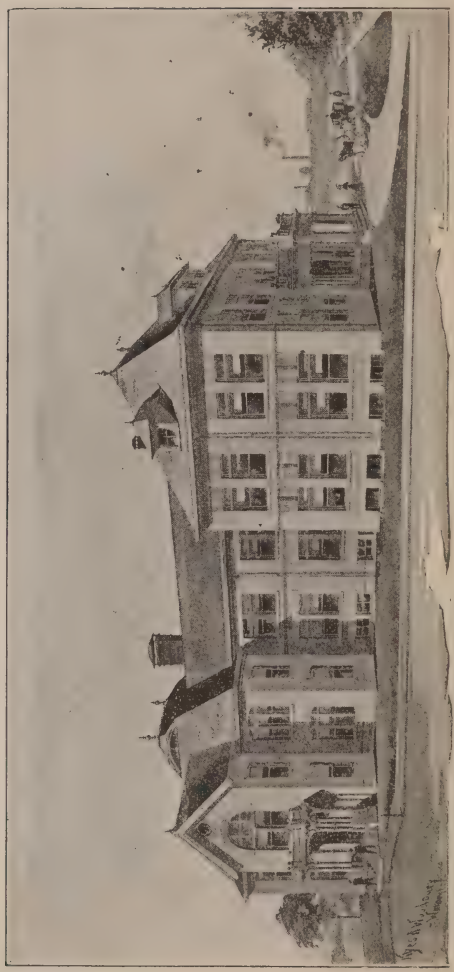
OUR HOPEDALE PLANT IN 1896.
Scale 280 feet to the inch.

We show this old illustration for purpose of comparison with the one on the opposite page. Our improvements during the last few years have filled up the pond shown above, and when completed will have entirely replaced at least half of the old plant by new structures.



OUR HOPEDALE PLANT IN 1901.
Scale 315 feet to the inch.

All the above buildings as shown are completed with the exception of the new Carpenter Shop and Machine Shop which are now in progress. The Wood Working plant and Pattern Safe are isolated for protection against fire but otherwise there is an unbroken connection throughout, making one united plant with central power and most convenient freight facilities.



OUR OFFICE BUILDING.

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It is our purpose to make this book a compendium of useful information for everyone connected with the manufacture of cotton cloth or yarns. While some of our specialties are equally applicable to woolen, worsted and silk manufacture, we feel that the cotton mill is our legitimate field of action and broad enough to require the greater part of our time. In connection with the general information furnished, we introduce descriptions of our machinery, and rules and tables of great interest to the practical manufacturer. These tables in many cases are merely the results of mathematics and formulæ, and have been published by us before. Others, however, are figured from actual results gathered from hundreds of mills, and properly averaged. The latter are of great practical value. In this present edition, new tables are presented whenever the conditions have made such change necessary.

This book is copyrighted, and we hope to see that copyright respected. We expect to issue a sufficient number of copies so that all men occupying responsible positions in Cotton Mills may have them on demand.

THE DRAPER COMPANY.

COTTON MANUFACTURING.

The manufacture of cotton yarn and fabrics by machinery, practically started with the development of the steam engine. The hand processes of the earlier centuries had already covered nearly every possible combination of threads in fabrics, some of the coverings found on the ancient Egyptian mummies, showing figured goods of intricate design, often made with yarn of comparatively fine numbers. The art of making cloth was known even in pre-historic times, samples of woven stuffs having been found among the ruins of the Swiss lake-dwellers. Nearly all of the earlier primitive processes continue in use to-day, in various parts of the world, the distaff, spinning wheel and hand loom, being still known to civilization.

Whole volumes have been written about the early progress of the industry, and, rather than consume space and time, we condense the pertinent facts into a chronological table. Certain authorities differ with regard to many of the earlier dates, and it is possible that an injustice may be done to some unknown inventors in accepting the statements given. Every successful invention, however, is claimed by several owners, and we must trust to history, more or less, to weed out the errors.

Patent dates from 1730 to 1790 are all for English inventions. From that date on they are to be understood as American inventions unless otherwise specified.

1730—First cotton yarn spun in England by machinery by Wyatt.

1733—English patent granted John Kay for the invention of the fly shuttle.

1738—Patent granted Lewis Paul for the spinning machinery supposed to have been invented by Wyatt.

1742—First mill for spinning cotton built at Birmingham; moved by asses; but not successful.

1748—Patent on a cylinder card as first used by hand, granted Lewis Paul.

1750—Fly shuttle in general use in England.

1756—Cotton velvets and quiltings first made in England.

1760—Stock cards first used for cotton by J. Hargrave. Drop box invented by Kay.

1762 to 1767—Spinning-jenny invented by Hargrave.

1769—Arkwright obtains his first patent on spinning.

1774—Bill passed in England to prevent the export of cotton machinery.

1775—Second patent of Arkwright on carding, drawing and spinning.

1779—Mule spinning invented by Crompton.
Peele's patent on carding, roving and spinning.

1782—Date of Watt's patent for the steam engine.

1783—Bounty granted in England for export on certain cotton goods.

1785—Power looms invented by Dr. Cartwright. Cylinder printing invented by Bell. A warp stop motion described in Cartwright's patent.

1788—First cotton factory built in the United States at Beverly.

1789—Sea Island cotton first planted in the United States.
Samuel Slater starts cotton machinery in New York.

1790—First cotton factory built in Rhode Island by Slater.

1792—First American loom patent granted.

1794—Cotton gin patented by Elias Whitney.

1801—Date given for invention of the Jacquard machine in France.

1803—Dressing machine and warper invented in England by Radcliffe, Ross and Johnson.

1804—First cotton mill built in New Hampshire, at New Ipswich.

1805—Power loom successfully introduced in England after many failures.

1806—First cotton mill built in Connecticut, at Pomfret.

1809—First cotton mill built in Maine, at Brunswick.

1814—Cotton opener with lap attachment invented in England by Creighton.

1815—Power loom introduced into the United States at Waltham.

1816—First loom improvement of Ira Draper patented in the United States.

1818—Machinery for preparing sewing cotton invented in England by Holt.

1820—*Revolving loom temple invented by Ira Draper.

1822—First cotton factory erected at Lowell.

1823 { Differential motion for roving frames patented by Arnold.
First export of raw cotton from Egypt to England.

1824—Tube frame or speeder patented by Danforth.

1825—Self acting mule patented in England, by Roberts.

1828 { Ring spinning patented by John Thorpe.
Cap spinning patented by Danforth.

1829—*Revolving loom temple improvements patented by Ira Draper.

1832—Stop motion for drawing frames invented by Bachelder.

1833—Ring spinning frames first built by William Mason.

1840 { Filling stop motion for looms introduced.
Automatic loom let-off of E. B. Bigelow invented about this time.
*Important temple improvement patented by George Draper.

1846—*Parallel shuttle-motion patented by W. W. Dutcher.

1847—First cotton mill built at Fall River.

1849—First cotton mill built at Lawrence.

1850—*Date of Hayden's patent for railway head evener.

1851—*Date of reciprocating temple patent of E. and W. W. Dutcher.

1853—Date of card-cleaning patent of G. Wellman.

1857—*Date of Snell & Bartlett's let-off patent.

1859 { Date of Cheetham shuttle-changing loom patent, the first American attempt in this direction.
*Date of Stearn's shuttle-motion patent.

1862 { *Date of Shepard's let-off patent.
*Date of card-guide patent of Hervey Kent.

1863—*Date of Geo. Draper's loom stop motion, used on every side dagger loom in the country.

1865—Date of Thomas Mayor's patent on roving frame improvements.

1866—Date of first spindle patent, to J. E. Atwood.

1867 { *Date of Cottrell & Draper's double beam let-off patent.
*Date of important spindle patent granted Rabbeth & Atwood.

1868 { *Date of W. F. Draper's thin place preventer patent for looms.
*Date of first American self-threading shuttle patent of J. A. Metcalf.
*Date of patent of F. Haythorn, for the first spinning frame separator.

1869 — Date of important loom patent of Erastus B. Bigelow.
*Date of first bobbin-holder patent, of A. M. Wade.
*Date of W. T. Carroll's double-flange spinning ring patent.
*Date of first inside-catch shuttle patent, to J. H. Coburn.

1870 — *Date of patent on the original Walmsley warper stop motion.
Date of Oliver Pearl's celebrated spindle patent.

* These devices all came under control of Hopedale interests at some period of their patent existence.

A revision of the state of the art finds much of interest hidden within the forgotten volumes of patent records. Hundreds of names of those attempting to improve cotton machinery are perhaps only preserved by some of these olden patents, whose value never was proved.

It is interesting to note that Thorpe, who undoubtedly invented the principle of ring spinning, took out patents on looms as far back as 1812, one being on that often tried idea of an upright loom, in 1816. Samuel Slater took out a spinning patent in 1825. Erastus B. Bigelow began to take out his long series of important patents in 1837, being by far the most prolific of the various loom inventors of his time. William Mason took out his first mule patent in 1840 and Richard Kitson a card grinding patent in 1851. The name of B. H. Jenks first appears in 1852, the one so long associated with the products of the Bridesburg Company, with George Crompton following in 1854. The name of Lucius J. Knowles appears soon after in 1856. Smith and Skinner's carpet-loom inventions appear to have started in the same year. The name of Colvin is associated with a loom patent in 1858, and that of Furbush, in 1859. John C. Whitin took out a card patent in 1863. Thus nearly all of the present cotton machinery builders were represented by an inventive ancestry. Specific instances of invention by other parties up to 1870, have already been noted.

From this period the development of improvements in the cotton manufacturing industry is so closely associated with the now related detail of the business formerly done by the various firms and corporations, represented by the Draper Company, that we end our table with this last date, leaving the task of its amplification to posterity.

Passing to consideration of our own immediate affairs, the record may be briefly summarized as follows:

Our business, up to 1870, was largely devoted to the introduction of temples and other loom improvements. We had applied or sold the right to use our let-off motions on over 50,000 looms at the time. From the catalogues printed since 1870, the following list of important inventions introduced by Hopedale organizations may be taken:

The earlier devices included the Kent card-guide, the railway head evener, (on which royalty was paid by all the large outside cotton machinery manufacturers at the time), a line of patent bolsters and steps for spindles on spinning frames, fly frames and mules, the Hopedale warper, (which has always controlled the majority of sales in this line), the Carroll double adjustable spinning ring, and nearly all the parallel shuttle motions, let-off motions, and shuttle guides then in use. There was also a large and important business carried on in the introduction of the patent Thompson oil can.

Many men have an opinion that patented articles are often introduced by the influence and persistence of the men handling them, rather than by the intrinsic merit of the ideas. It is, therefore, interesting to note, in this connection, that all the devices mentioned have continued in use after the expiration of their patents, the former competitors, who decried their value so long as they were restricted by patent protection, falling into line and manufacturing the identical articles themselves, immediately after the protection lapsed. Thus every railway head of to-day has an evener, the double ring controls the market, and the Stearns picker-motion, and Bartlett let-off motion are still universal favorites. Some of our former lines were abandoned as soon as the patents expired, we gradually dropping the introduction of loom improvements, with the exception of temples, and practically abandoning the card room.

In 1872 we had commenced the introduction of the Sawyer spindle improvements, and taken hold of the Damon cut marker.

By 1873 the Sawyer spindle was fairly started. The history of this invention, including its competition and victory over the Pearl, early Rabbeth, and other types, with its record of continuous litigation, includes the most interesting part of our business experience.

We had also by this time, started on the manufacture of spoolers.

By 1876 we were building twisters, a line in which we have always maintained a place in the front rank, and were using the Wade bobbin holder and Laflin Guide on our spoolers.

By 1881 we were changing from the Sawyer to the Rab-

beth self-centering type of spindle, were introducing the evener for filling frames, inside catch shuttles, the Doyle separator, the Weeks banding machine, a new reel, and certain speeder improvements.

By 1887 we were introducing an improved roving frame, the Sherman and Whitin spindles in addition to the Rabbeth style, the Clark balling machine, the Walcott warper, an entirely new twister and a line of automatic sprinklers.

By 1893 the celebrated 49D spindle had been our standard for some time.

By 1896 we had passed on to the Draper spindle, the Rhoades-Chandler separator, the cone-drive and other important warper improvements, the Straw chain-dyeing process, the Smith twister stop-motion and the Northrop loom. To-day we have important improvements in all the former lines, but no departure into new fields to any great extent. The surprising growth of our loom business has limited attention to further new ventures.

The dates, as given, are those of our catalogues, rather than those of the exact dates at which the various machines mentioned were first sold. The importance of the various ideas is fully realized by the public, who have never failed to appreciate our improvements. In the lines of spinning, warping, spooling and plain weaving, we claim nearly all the really vital changes of the last thirty years. Some time ago it was figured that our changes in the spinning frame alone had made a profit of $50,000,000 to the cloth producer and consumer in this country; and the gains of our Northrop loom will dwarf such figures into comparative insignificance.

We have always realized that a business founded on the introduction of patented improvements could only be successful by continual application, for patent protection is by no means continuous or secure. We keep a large force of inventors and draughtsmen continually busy over the betterment of our products, and, for every novelty that is known by the trade, there are surely ten failures, each of which has usually consumed time and expense equal, at least, to that involved in the success. We have paid hundreds of thousands of dollars for inventions that have never been of the slightest value, have purchased hundreds of patents for no purpose but protection against the possible competitor, and made thousand of patterns for machinery that never left the works. All of these facts should be realized by the oft times, short sighted customer, who figures in his mind the possible profits we are deriving from some apparently high priced machine, without knowing the extent of the losses which have to be charged against the account.

Machinery improvements are, by no means, granted prompt appreciation or acceptance. The view of the opposition is nowhere better stated than in the first paper presented at the first meeting of the New England Cotton Manufacturers' Association, on July 18, 1866. Mr. Franklin Forbes, of the Lancaster Mills, then said as follows:

"*In consequence of the highly suggestive and inventive talent of New England, there is, I think, a tendency to change unnecessarily and to multiply machinery and apparatus beyond the requirements of the yarn, or the fabric into which our yarn is woven. Whether we are not unduly influenced in this regard by the pertinacity of inventors, patentees, dealers in patented articles, or parties interested to keep machine shops running, or the pride of our help and overseers in making a good show and using nice appliances, it is scarcely proper to spend time now in inquiring. Suffice it to say that complicated machines, and complicated processes for doing simple things are fair objects of opposition.*"

If it were only possible to accomplish the desired results by simple means, all would heartily agree with this statement. Unfortunately, nature's evolution of things does not allow a wide range of utility with a small range of means. When we attempt to imitate the possibilities of manual labor by mechanism, we are constantly involved in adding parts and attachments to original conceptions. The mule is much more complicated than the spinning wheel, the present frame spindle has many times the parts of the early common type, and the Northrop loom undoubtedly multiplies mechanism; but the results accomplished authorize the changes, no one being willing to go back to the older processes after having grown accustomed to the new.

There is another associating factor shown to be of vital importance in the development of those who use the machines. The more highly complicated the mechanism becomes, the higher the grade of brain demanded in the operative, and the better chance for brains to win rank in comparison. We believe that we possess in this country the most gifted labor in the world. Whether the operatives have developed the machinery, or the machinery the operatives, is a matter that may be discussed elsewhere; but the fact remains that the combination of machine and operative often enables us to enter into competition with older countries and with people willing to accept less wages for their toil.

While we will always make it worth the while of any inventor or designer who can simplify any of our mechanism, and still preserve its utility, we shall never be afraid of complication whenever there is a possible mechanical achievement manifestly

worth the doing, either by reason of its great profit to the user, or by the incidental lesser profit to ourselves.

In the earlier application of inventive talent to cotton machine processes, the irresponsible nature of certain patent claims aroused a feeling of concern among many manufacturers, who actually considered the question of organizing in order to protect their interests and improve their relations with patentees. It was then quite common for mills to buy the rights for patented inventions from people of no financial standing, and then be forced to pay royalty to some other party for the same invention, it being impossible to recover from the first claimant. Suits at law against mills were not uncommon, and the agent, or manager was, of necessity, forced to qualify himself, more or less as a patent expert. Although our former firm and its predecessors, had been introducing patented improvements for many years, their personal actions were in no way responsible for this feeling, as, up to this time, they had never brought suit, or been sued, on account of any patent or invention. Increasing responsibilities and enlargement of business, however, soon brought the necessity for legal action, and the outcome has been fortunate for all parties concerned. Continued success has developed a business in the introduction of patented improvements that is responsible enough to stand back of customers, and guarantee them protection. No manufacturer purchasing any of our improvements has ever paid a dollar to any other party for royalty on any of them, or to defend himself against claims of infringement. By controlling the majority of new ideas in the lines of spinning, warping, spooling, twisting, and, latterly, plain weaving, we relieve the mill of annoyance by standing between it and the inventor, as patentees bring their ideas to us instead of asking for trial at the mill. Our knowledge of the state of the art is usually sufficient to prevent wasting the mill's time on old ideas, and we have facilities for doing a great part of the necessary testing without troubling them. In case it is necessary to make a mill trial, we usually have found it possible to compensate for the annoyance in some way or other.

The public will probably never realize what has been saved to them by the concentration of these inventive lines. Without it there would be dozens of ideas brought to the attention of agents and treasurers, each claiming superiority, and the mills themselves would have to eventually bear the cost of experiments, and run the risk of vexatious litigation. With the possible adoption of various different styles of mechanism, there would be serious complication in the way of repairs and interchangeability. By concentrating capital and experience we are enabled to venture on tests and experiments that, under

ordinary circumstances, would never have been tried. It has, of course, been impossible for us to absolutely prevent our customers from being troubled by the solicitations of outsiders, whose ideas have not found favor with us, or who have started an attempt at competition, with the hope of either being bought out by us, or possibly happening on some chance to win a share of our profits. Where many bright men are working in the same line it is, of course, possible that many may hit somewhere near the mark at the same time. It is not practical, however, to attempt to make a commercial machine from each of the various ideas, as that would involve expensive complications. Those who are necessarily passed by, sometimes attempt an independent success; and competition of this nature is not at all times undesirable. That class, however, who give their time in palpable endeavor to evade patent claims, and produce a plausible imitation of some successful device, are attempting to serve no practical purpose for the community at large. We never yet started with the desire of making something just as good as that already known, or something that might lessen the success of a deserving inventor. We have simply aimed to better the processes of cotton manufacture, trusting to public recognition to determine our compensation.

STATISTICS.

As this work is frankly intended to arouse interest in the further development of American cotton manufacture, it may be well to consider the past results, which prove the continued, unfaltering advance of this typically American industry. In collecting the figures tabulated, many perplexing differences were found, some of the statements in former literature being so absolutely out of proportion to the known facts that they were absolutely useless. Any summary of this kind must be considered as more or less approximate. In the given numbers of spindles it has been intended to figure those actually in use rather than add in those not working at the period mentioned. Even as it is, they are more or less misleading, for spindles vary so much in style and capacity, as to prevent use as a standard unit for computation.

Figures of spindles as usually given are apt to be somewhat in excess of the actual number in operation, as the information at hand is necessarily based on misleading figures.

A great many new mills are figured in, at times, that have simply placed orders for machinery, which may not be delivered till the next year. A great many new spindles displace the older type, which stop running. There are also many spindles figured which simply represent promoters' dreams, the mills that were to contain them never being built at all. In revising a total of this nature recently, it was found, by careful count, that the figures for one state alone were nearly 300,000 in excess of the actual number. In the table given, the figures from 1890 to 1900 are taken from Col. Shepperson's estimates, the results of the census not being known at the time this compilation was made.

The growth of the cotton industry of this country will undoubtedly follow the well worn track of business evolution. We raise the most important supply of the world's cotton, and shall eventually make our exports of cotton in rolls of cloth, rather than in bales of fibre. The fact that our labor is more highly paid, forces us to demand a higher grade of skill and intelligence from the operative, or trust in better organization, or use of more improved processes. It is well known that Americans are quicker to adopt new systems than any other people on the globe, and the modern American cotton mill is certainly run with a strict regard to economies.

The question of enlarging the present American industry depends more or less on the encouragement given capital. Our census figures show a certain persistent increase in population, which allows a definite estimate of increased consumption of cotton goods, and the development of our export trade in cotton fabrics in late years is certainly encouraging. Our Southern mills are understood to have earned large dividends, and as the bulk of the new mills have been erected in the South, it would seem to prove that returns in this section were larger than in the North. The profits of new mills are, however, often figured without a proper consideration of depreciation, so that it is necessary for one to figure returns over a term of years that will provide for a proper average of replacements before being absolutely sure of his basis of computation.

	Capital Invested in Cotton Manufacturing in the United States.	Value of Products.	Number of Spindles.
1801			
1802			
1803			
1804			
1805			4,500
1806			
1807			8,000
1808			
1809			31,000
1810			87,000
1811			
1812			
1813			
1814			122,646
1815			130,000
1816			
1817			
1818			
1819			
1820			220,000
1821			230,000
1822			
1823			
1824			
1825			
1826			
1827			705,000
1828			
1829			
1830			
1831	$40,612,984	$32,000,000	1,246,703
1832			
1833			
1834			
1835			1,750,000
1836			
1837			
1838			
1839			
1840		$46,350,453	2,285,337
1841			
1842			
1843			
1844			
1845			
1846			2,500,000
1847			
1848			
1849			
1850	$74,500,934	$61,869,184	2,751,078

	Capital Invested in Cotton Manufacturing in the United States.	Value of Products.	Number of Spindles.
1851			
1852			
1853			
1854			
1855			
1856			
1857			
1858			
1859			
1860	$98,585,269	$115,681,774	5,235,727
1861			
1862			
1863			
1864			
1865			
1866			
1867			
1868			
1869			6,700,557
1870	$140,706,291	$177,489,739	7,132,415
1871			
1872			
1873			
1874			9,415,383
1875			
1876			
1877			
1878			
1879			
1880	$208,280,346	$192,090,110	10,635,435
1881			11,375,000
1882			12,150,000
1883			12,660,000
1884			13,300,000
1885			13,375,000
1886			13,400,000
1887			13,500,000
1888			13,550,000
1889			14,060,000
1890	$354,020,843	$267,981,724	14,405,000
1891			14,640,000
1892			15,200,000
1893			15,550,000
1894			15,700,000
1895			16,100,000
1896			16,650,000
1897			17,150,000
1898			17,450,000
1899			18,100,000
1900			20,000,000

The following figures from the census of the year 1890 have been printed before, but they still have use for purposes of comparison with later figures.

GEOGRAPHICAL DIVISIONS.	NEW SPINDLES.	INCREASE.
	Number.	*Per Cent.*
New England States	2,104,068	24.37
Middle States	242,558	17.44
Southern States	1,011,952	186.69
Western States	76,090	86.33

The tables below show the number of spindles per mill, in 1890, and the wages paid per spindle. They show conclusively that New England at the time had the advantage of large plants, while the South had cheaper labor.

GEOGRAPHICAL DIVISIONS.	NUMBER OF MILLS.	NUMBER OF SPINDLES.	SPINDLES PER MILL.
New England States	402	10,736,155	26,706
Middle States	239	1,633,722	6,835
Southern States	239	1,554,000	6,502
Western States	24	164,226	6,842

GEOGRAPHICAL DIVISIONS.	WAGES.	WAGES PER SPINDLE.
New England States	$69,489,272	$6.47
Middle States	10,763,873	6.58
Southern States	7,817,069	5.03
Western States	999,739	6.08

The following table shows the classes of goods produced in this country in the year 1890. It will be found that about two thirds of the cloth produced is simple two harness work.

PRODUCTS.	UNITED STATES.	
	Quantity.	Value.
Total value of all products..	....	$267,981,724
Plain cloths for printing or converting (square yards).	955,294,320	43,550,174
Brown or bleached sheetings or shirtings (square yards).	962,238,062	55,193,439
Drills, twills and sateens (square yards).	334,020,091	23,601,239
Ginghams (square yards)	268,996,715	20,686,390
Cotton flannels (square yards)..	132,524,706	10,574,924
Fine or fancy woven fabrics (square yards).	127,373,179	12,545,929
Duck (square yards)	55,192,538	8,664,395
Ticks, denims, and stripes (square yards)	167,121,426	16,987,546
Upholstery goods	....	2,070,239
Bags or bagging..	....	3,107,413
Tape and webbings.....	....	1,759,512
Yarns for sale (pounds).....	166,397,003	33,247,596
Sewing cotton (pounds)	13,868,309	11,637,500
Twine (pounds).....	8,533,730	1,364,300
Batting or wadding (pounds)	20,470,556	2,094,232
Rope (pounds).....	3,590,228	479,415
Waste (pounds)	141,109,570	5,679,701
All other products	....	14,737,780

From a list published in 1898 it can be figured that 34 New England cotton mills, with an average capitalization of $600,000 each, had averaged to pay 6.37 per cent. in dividends for a period of ten years. The capitalization as given, figured about $8.74 per spindle, showing the value fairly represented by the capital stock, allowing for ample depreciation on old machinery. Taking out the five highest and the five lowest, which might possibly be misrepresented by the capital stock showing, it is found that the average capitalization of the remaining twenty-four mills is still $600,000. The capitalization per spindle is also nearly the same, viz: $8.70, while the dividends figure an even 6 per cent.

This simply proves that through an exténded period, involving several years of panic prices, these mills not only paid good dividends, but kept their capitalization relatively low. The returns for the investor at the lower figure of six per cent. are net for the Massachusetts owners, as they pay no taxes on stock in Massachusetts corporations. Investments in railroads would certainly not average 5 per cent., as that typically Massachusetts institution, the Boston & Albany Railroad, sold on a basis netting less than 4 per cent during the same period. The general standing of cotton manufacturing securities is of the highest grade, as stock jobbing schemes are un-

known in connection with the industry, and the original stock invariably represents par value.

There is always a field for new cotton mills so long as old mills with obsolete machinery can run, and the many antiquated processes still in use give sufficient warrant for consideration of a competitive profit.

As to the location of a mill at the present time, there are certain serious matters for consideration. The South sometime ago practically monopolized the field for coarse goods, although several Northern competitors still maintain their rank among the most successful in their locality. The line is no longer drawn at print cloths, which were once considered too fine for Southern manufacture. The North still has the advantage of longer acquaintance with the business, larger supply of skilled labor, and nearness to machinery supplies. The South is beginning to get a little over-crowded in certain sections, and the growing scarcity of labor may eventually raise the price of wages to a point which will eliminate one of their present advantages. Looking at the matter from a broad standpoint, it makes little difference to the average American about what part of the country does his manufacturing, so long as we do not rely on foreigners to supply us with our demands. There is still quite a field in the finer styles of goods where American manufacturers must defeat foreign rivals. The Northern mill should naturally pre-empt this chance, and the Southern mill will stand ready to fill up the gap, as the Northern fabrics grow finer in grade.

A rough estimate in round figures of the spindles in use in various countries at the end of the century is as follows:

Great Britain,	46,000,000
United States,	20,000,000
Germany,	8,000,000
Russia,	8,000,000
France,	5,500,000
Austria,	3,000,000
Spain,	2,500,000
Italy,	2,000,000
Switzerland,	2,000,000
Belgium,	1,000,000
Sweden, Holland, Portugal, Greece	1,000,000
India,	5,000,000
Japan,	1,500,000
China,	500,000
	106,000,000

It must be understood that the term spindle by no means signifies an unalterable unit. Many of these spindles are old in type and the division between mule and frame spindles cannot be easily determined.

Table showing prices of Print Cloth and Cotton with margin for manufacturing cost and profit. Average of print cloth price is not exactly correct, as it is made by an average of yearly high and low prices rather than by average of daily prices.

Year.	Highest Price of Print Cloth in Cents.	Lowest Price of Print Cloth in Cents.	Average of High and Low Price in Cents.	Price per Lb. in Cents, at 7 Yds. per Lb.	Average Price of Middling Uplands per Lb. in Cents.	Probable Cost per Lb. of Cotton Used in Cents, Allowing for 20 per cent. Waste.	Margin Between Cotton and Cloth in Cents per Lb.
1850	$5\frac{3}{4}$	5	$5\frac{3}{8}$	37.62	12.34	14.81	22.81
1851	$5\frac{1}{4}$	$4\frac{1}{2}$	$4\frac{3}{4}$	33.25	12.14	14.56	18.69
1852	$5\frac{3}{4}$	$4\frac{1}{4}$	5	35.	9.50	11.40	23.60
1853	$6\frac{3}{8}$	6	$6\frac{3}{16}$	43.31	11.02	13.22	30.09
1854	$6\frac{1}{4}$	$5\frac{1}{2}$	$5\frac{7}{8}$	41.12	10.97	13.16	27.96
1855	$5\frac{1}{2}$	$4\frac{3}{4}$	$5\frac{1}{8}$	35.87	10.39	12.46	23.41
1856	$5\frac{3}{4}$	5	$5\frac{3}{8}$	37 62	10.30	12.36	25.26
1857	$6\frac{1}{8}$	$5\frac{7}{8}$	6	42.	13.51	16.21	25.79
1858	6	5	$5\frac{1}{2}$	38.50	12.23	14.67	23.83
1859	$5\frac{7}{8}$	$5\frac{1}{2}$	$5\frac{11}{16}$	39.81	12.08	14.49	25.32
1860	$5\frac{3}{4}$	$4\frac{7}{8}$	$5\frac{5}{16}$	37.18	11.	13.20	23.98
1861	9	$4\frac{1}{4}$	$6\frac{5}{8}$	46.37	13.01	15.61	30.76
1862	$14\frac{1}{2}$	7	$10\frac{3}{4}$	75.25	31.29	37.51	37.74
1863	19	$10\frac{3}{4}$	$14\frac{7}{8}$	104.12	67.21	80.65	23.47
1864	$38\frac{1}{2}$	$16\frac{1}{4}$	$27\frac{3}{8}$	191.37	101.50	121.80	69.57
1865	$27\frac{1}{4}$	10	$18\frac{9}{8}$	130.37	83.38	100.05	30.32
1866	$19\frac{1}{2}$	$11\frac{1}{4}$	$15\frac{3}{8}$	107.62	43.20	51.84	55.78
1867	12	$6\frac{7}{8}$	$9\frac{5}{10}$	65.18	31.59	37.90	27.28
1868	$9\frac{5}{8}$	$6\frac{1}{2}$	$8\frac{1}{16}$	56.43	24.85	29.82	26.61
1869	$9\frac{1}{2}$	$7\frac{5}{8}$	$8\frac{5}{16}$	58.18	29.01	34.81	23.37
1870	$8\frac{1}{4}$	$6\frac{1}{2}$	$7\frac{3}{8}$	51.62	23.98	28.77	22.85
1871	8	$6\frac{1}{2}$	$7\frac{1}{4}$	50.75	16.95	20.34	30.41
1872	9	$7\frac{3}{8}$	$8\frac{3}{16}$	57.31	20.48	24.57	32.74
1873	$7\frac{1}{2}$	$5\frac{3}{4}$	$6\frac{5}{8}$	46.37	18.15	21.78	24.59
1874	$6\frac{1}{2}$	$5\frac{1}{4}$	$5\frac{11}{16}$	39.81	17.	20.40	19.41
1875	$6\frac{1}{2}$	$4\frac{5}{8}$	$5\frac{9}{16}$	38.93	15.	18.	20.93
1876	$4\frac{5}{8}$	$3\frac{5}{8}$	$4\frac{1}{8}$	29.75	13.	15.60	14.15
1877	$5\frac{1}{2}$	$3\frac{5}{8}$	$4\frac{7}{16}$	31.06	11.73	14.07	16.99
1878	4	$3\frac{1}{2}$	$3\frac{9}{16}$	24.93	11.28	13.53	11.40
1879	$4\frac{1}{2}$	$3\frac{3}{16}$	$3\frac{27}{32}$	26.90	10.83	12.99	13.91
1880	$5\frac{87}{100}$	$3\frac{3}{4}$	$4\frac{81}{100}$	33.67	12.02	14.42	19.25
1881	$4\frac{1}{4}$	$3\frac{3}{4}$	4	28.	11.34	13.60	14.40
1882	$3\frac{905}{1000}$	$3\frac{5}{8}$	$3\frac{7.8}{10.0}$	26.46	12.16	14.59	11.87
1883	$3\frac{13}{16}$	$3\frac{4.4}{10.0}$	$3\frac{6.4}{10.0}$	25.48	10.63	12.75	12.73
1884	$3\frac{832}{1000}$	$3\frac{8}{10.0}$	$3\frac{3.6}{10.0}$	23.45	10.64	12.76	10.69
1885	$3\frac{1}{4}$	$2\frac{9.8}{100}$	$3\frac{1.1}{100}$	21.77	10.54	12.64	9.13
1886	$3\frac{5}{8}$	$3\frac{1}{8}$	$3\frac{8}{16}$	23.18	9.44	11.32	11.86
1887	$3\frac{5}{8}$	$3\frac{1}{4}$	$3\frac{7}{16}$	24.06	10.25	12.30	11.76
1888	4	$3\frac{1}{2}$	$3\frac{3}{4}$	26.25	10.27	12.32	13.93
1889	$4\frac{1}{16}$	$3\frac{1}{2}$	$3\frac{25}{32}$	26.46	10.71	12.85	13.61
1890	$3\frac{9}{10}$	3	$3\frac{9}{32}$	22.96	11 53	13.83	9.13
1891	$3\frac{7}{16}$	$2\frac{3}{4}$	$2\frac{29}{32}$	20.34	9.03	10.83	9.51
1892	$4\frac{1}{16}$	$3\frac{1}{16}$	$3\frac{9}{16}$	24.93	7.64	9.16	13.77
1893	4	$2\frac{7}{8}$	$3\frac{3}{8}$	23.62	8.24	9.88	13.74
1894	3	$2\frac{1}{2}$	$2\frac{3}{4}$	19.25	7.67	9.20	10.05
1895	$3\frac{5}{16}$	$2\frac{7}{16}$	$2\frac{7}{8}$	20.12	6.62	7.94	12. 8
1896	3	$2\frac{7}{16}$	$2\frac{23}{32}$	19.03	8.16	9.79	9.24
1897	$2\frac{1}{16}$	$2\frac{1}{4}$	$2\frac{15}{32}$	17.18	7.72	9.26	8.02
1898	$2\frac{3}{16}$	$1\frac{7}{8}$	$2\frac{1}{32}$	14.21	6.22	7.46	6.75
1899	$3\frac{1}{4}$	$2\frac{3}{8}$	$2\frac{13}{16}$	19.68	6.	7.20	12.48
1900	$3\frac{1}{2}$	$2\frac{3}{4}$	$3\frac{1}{8}$	21.87	8.56	10.27	11.60

COTTON.

The cotton plant is mainly grown in the United States, India, Egypt, China, Brazil and Asiatic Russia. The cotton crop of the United States is the most important and the most useful, its price practically controlling that of other cottons. The Sea Island and Egyptian cottons have the longer staple, while the Chinese and Indian varieties are very short in staple. These latter cottons are practically consumed in the countries in which they are raised.

In the cotton crop statistics, as given, various sources of figures have been consulted, and no one source accepted throughout. Not knowing the different methods of computation employed by different parties, it is impossible to combine with accuracy; yet, the table given should be sufficient for practical purposes. The figures from 1870, on, are copied by courtesy of Colonel A. B. Shepperson, from various editions of his "Cotton Facts." The prices from 1821, on, are understood to be for Middling Upland cotton, in New York. Read this column with relation to the *first* column of yearly figures.

Tables are sometimes given for the crop in earlier years, where the commercial bale weighed but 250 pounds. Modern statistics are figured with the bale at 450 pounds net, so that the term "bale" by no means conveys an unchanging meaning. It is necessary to standardize on some unit, for the weight of bales varies with different seasons showing a tendency to increase each year. Thus, the net weights which average 420 pounds in the season of '55--'56, reached an average of 484 pounds in the season '94-95. Gross weights have run as high as 530 pounds in certain states, for an average season. Egyptian bales are compressed into a size somewhat similar to the American bale, but the average weight is usually over 700 pounds. The Indian bales, on the contrary, which are also more closely compressed than the American, usually weigh about 400 pounds. The Egyptian bale is packed to a density of 45 pounds to the cubic foot, against perhaps 22 pounds for the ordinary American bale.

Grades of cotton:

Ordinary.	Middling.
Strict ordinary.	Strict middling.
Good ordinary.	Good middling.
Strict good ordinary.	Strict good middling.
Low middling.	Middling fair.
Strict low middling.	Fair.

Cotton is purchased by most manufacturers in the shape of a bale. Southern mills in cotton raising sections can have

Cotton Crop of the United States Expressed in Statistical Bales of 450 Pounds Net Weight.

Year.	Crop.	Average Price in Cents.
1788-89	2,000	14.5
1789-90	3,000	26.
1790-91	4,000	29.
1791-92	7,000	32.
1793-94	11,000	33.
1794-95	11,000	36.5
1795-96	22,000	36.5
1796-97	24,000	34.
1797-98	33,000	39.
1798-99	44,000	44.
1799-00	77,000	28.

For the Century, 1800–1900.

Year.	Crop.	Average Price in Cents.
1800-01	105,000	44.
1801 02	120,000	19.
1802-03	133,000	19.
1803-04	143,000	20.
1804-05	155,000	23.
1805-06	177,000	22.
1806-07	175,000	21.5
1807-08	166,000	19.
1808-09	182,000	16.
1809-10	189,000	16.
1810-11	178,000	15.5
1811-12	166,000	10.5
1812-13	166,000	12.
1813-14	155,000	15.
1814-15	222,000	21.
1815-16	275,000	29.5
1816-17	288,000	26.5
1817-18	278,000	34.
1818-19	370,000	24.
1819-20	355,000	17.
1820-21	399,000	14.32
1821-22	466,000	14.32
1822-23	410,000	11.40
1823-24	477,000	14.65
1824-25	566,000	18.59
1825-26	776,000	12.19
1826-27	703,000	9.29
1827-28	535,000	10.32
1828-29	659,000	9.88
1829-30	735,000	10.04
1830-31	786,000	9.71
1831-32	789,000	9.38
1832-33	831,000	12.32
1833-34	971,000	12.90
1834-35	1,023,000	17.45
1835-36	1,127,000	16.50
1836-37	1,198,000	13.25
1837-38	1,517,000	10.14
1838-39	1,160,000	13.36
1839-40	1,853,000	8.92
1840-41	1,431,000	9.50
1841-42	1,485,000	7.85
1842-43	2,161,000	7.25
1843-44	1,858,000	7.73
1844-45	2,208,000	5.63
1845-46	1,918,000	7.87
1846-47	1,681,000	11.21
1847-48	2,260,000	8.03
1848-49	2,777,000	7.55
1849-50	2,222,000	11.
1850-51	2,268,000	12.34
1851-52	2,973,000	12.14
1852-53	3,325,000	9.50
1853-54	2,937,000	11.02
1854-55	2,876,000	10.97
1855-56	3,410,000	10.39
1856-57	3,051,000	10.30
1857-58	3,199,000	13.51
1858-59	3,991,000	12.23
1859-60	4,980,000	12.08
1860-61	4,080,000	11.
1861-62	4,770,000	13.01
1862-63	1,696,000	31.29
1863-64	477,000	67.21
1864-65	318,000	101.50
1865-66	2,223,000	83.38
1866-67	2,069,000	43.20
1867-68	2,491,000	31.59
1868-69	2,334,000	24.85
1869-70	3,003,000	29.01
1870-71	4,255,000	23.98
1871-72	2,934,000	16.95
1872-73	3,900,000	20.48
1873-74	4,038,000	18.15
1874-75	3,770,000	17.
1875-76	4,580,000	15.
1876-77	4,412,000	13.
1877-78	4,758,000	11.73
1878-79	5,062,000	11.28
1879-80	5,835,000	10.83
1880-81	6,736,000	12.02
1881-82	5,449,000	11.34
1882-83	7,169,000	12.16
1883-84	5,805,000	10.63
1884-85	5,775,000	10.64
1885-86	6,700,000	10.54
1886-87	6,641,000	9.44
1887-88	7,240,000	10.25
1888-89	7,262,000	10.27
1889-90	7,653,000	10.71
1890-91	9,158,000	11.53
1891-92	9,473,000	9.03
1892-93	7,020,000	7.64
1893-94	7,905,000	8.24
1894-95	10,533,000	7.67
1895-96	7,553,000	6.62
1896-97	9,201,000	8.16
1897-98	11,972,000	7.72
1898-99	12,156,000	6.22
1899-00	9,997,000	6.00
1900-01		8.56

Read Price Column with reference to first column of year figures.

their cotton delivered by team direct from the gin, without going through the compress. In this way they save cost and the greater part of the transportation expense. They also save in the strength of the cotton fibre itself, providing that the process of compression injures the fibre. This, in our mind, is only a theoretical advantage. There is no doubt however, but that they get better cotton, being nearer the source of supply and having better opportunities for selection. The process of baling is receiving enough attention by interested parties to ensure a much more satisfactory trade bundle than formerly. However the cotton is finally delivered, it must be ginned first.

As to the process of ginning, it is supposed to separate the fibre from the seed and leaf. We say it is *supposed* to do so, because the cotton bale proves that the process is not at all satisfactory. We think the machines are probably overcrowded or speeded too high. Discussion is continuous regarding the merits of the roller gin versus the saw gin. The saw gin is said to mangle and tear the fibre in a way which the roller gin may prevent. There is no doubt but there is great chance here for invention, which will gin cotton in such a way as to thoroughly remove all foreign substances without harmful injury to the staple.

While the seed, dirt and leaf, which form nearly a tenth of the weight of the usual bale, can be extracted in the mill at the picker and card it is not equitable to have to pay for them at cotton prices.

When cotton arrives at the mill in the shape of a bale, it is found necessary to cut ties and loosen up the cotton before use. This may be done in two ways. One method being to pull the bale apart by hand, and the other to pass it through a bale breaker or similar machine which loosens up the cotton by means of beaters. The hand method is probably less liable to damage the cotton, but the question of expense may favor mechanical means. Some of the new round bales require special treatment.

When the cotton arrives at the mill it starts on a continuous journey through successive machines. In spite of the fact that such machine process is believed to tear and weaken the fibre more or less, we find that the higher grades of yarn and cloth demand the greater number of machine methods. The question as to the proper selection of machinery introduces chance for the gravest errors. An old mill management should have experience enough to guide them, but a new mill may easily err. Whenever a mill is built by capitalists who have had little experience in cotton manufacturing, it is usually wise to adopt suggestions of a competent mill engineer.

In cotton machinery, as well as other trades, there are well

known specialists. It is possible to buy an entire mill equipment from single concerns, but we should hesitate in advising such a course. The field is too broad for any one concern to monopolize the best products of every class. Realizing this we have personally devoted our energies to a few special machines and are confident that we excel in those lines.

OUR COTTON BALE SHEAR.

We have supplied the trade with shears of various patterns for many years. Our present device has given universal satisfaction wherever used, and we have sold many hundred pairs.

A device of this kind depends fully as much on workmanship and material as on design. We have never heard of any case where our present shears failed to give perfect satisfaction and a purchaser may be assured in advance that he is not trying an experiment. There is no need of argument against the old custom of cutting ties with a dull axe as the insurance people have condemned that for us. The question of expense need not stand in the way as the price is but $10 per pair.

Specify in ordering whether the ties to be cut are on American or Egyptian bales. The Egyptian bale having a wider tie, requires a different pattern of shear; a mill using both kinds of cotton, can use the Egyptian shear for both bales.

THE BOURNE TRAVELING PLATFORM
FOR PICKER ROOMS
CEILING
SIDE VIEW.
COTTON
END VIEW.
ENLARGED DETAIL END VIEW
FLOOR
LEVEL
ENLARGED DETAIL SIDE VIEW OF RACK AND PLATFORM.
CROW BAR!
THE PLATFORM PLANKS ARE INDEPENDENT.
ENLARGED DETAIL TOP VIEW OF RACK.
THE RACK IS SECURED TO THE FLOOR.
ENLARGED DETAIL END VIEW OF RACK.
FLOOR
LEVEL.

BOURNE PLATFORM.

In the usual process of delivering cotton from the bale to the picker, system is almost absolutely lacking and results entirely problematical. While it is known to be beneficial for the latter processes to have the cotton well mixed, aired and aged, it is practically impossible under ordinary circumstances without great care and expense. A system that would ensure regular mixing, airing and ageing, has important theoretical possibilities, and the practical results are found to be of great value.

Mr. Stephen N. Bourne of the Stark Mills, Manchester, N. H., some years ago, invented and put in application a process which is ideally perfect as regards proper handling of cotton. Besides being of importance as controlling the future processes in keeping the numbers even, it is economical, requiring less help to keep the cotton supplied to the pickers, and thoroughly systematic.

In line with each Opener Picker or Picker Feeder, is placed a traveling platform on which the cotton is fed. As the cotton is placed on the platform at one end and taken from it at the other, it is evident that the cotton being supplied is always aged by the time it takes to travel from one end of the platform to the other. In the two processes of loading and unloading the platform, the cotton is thoroughly mixed.

The platform, as shown in the descriptive cut, is simple and easily constructed by an ordinary carpenter. The only casting needed is the rack, which we can supply. The platform is made of separate planks which can be readily handled and moved from one end to the other. One man with a bar can move the entire load of platform and cotton. It is safe to figure about a bale to the foot when estimating the amount of cotton on a platform of the size shown. Details are governed by space which is at hand. The height, breadth or width of the platform and sides can be varied as found necessary.

We are ready to arrange with those desiring to use this system. We do not superintend the construction, but simply grant a license to use, and several mills have already taken advantage of this plan with most satisfactory results.

OPENING AND PICKING.

In arranging the picker room, care must be taken for precautions against fire, as the action of the swiftly revolving beaters is very apt to make sparks, providing any metal substance should be fed in with the cotton. Hot bearings can also make trouble, as there are many swiftly revolving shafts.

The picking machinery is the heaviest used in the ordinary manufacture of cotton into cloth, and great care must be exercised in setting it up and properly leveling the parts. All revolving shafts should run without cramping, and the beaters should be nicely balanced. It is not necessary to specify details, as only the usual mechanical skill is necessary. Unfortunately, all men who handle machinery are not mechanics in the proper meaning of the word. A little careful oversight therefore will do no harm.

Great improvement has been made in picking machinery in late years. Without going into the various rival processes, it can be stated as a general axiom that the method which cleans the cotton with the least mechanical action is probably the best.

The use of good modern feeders in the pickers' room will help more toward a thorough opening up and mixing of the fibre than any other single improvement. It will also tend to prevent crowding and make more even laps.

It is of course essential that an even lap be produced. A good clean lap cannot be made on any machine that is crowded, as there is not time or opportunity for dirt and leaf to separate from the fibre. Dirt should be removed from under the beaters with regularity, and cleanliness in this department should be regarded as a virtue of the highest order. Oiling should be attended to by a competent hand, as this machinery is more than usually liable to trouble from dry or hot bearings.

The overseer of this room should be a good manager, and should keep his accumulations of laps regular and not excessive. Picking machinery uses a great deal of air in the various fans, and we have always advised that this air be taken from the interior of the mill itself, rather than from the outside. We see no reason for changing our opinion.

THE WARD & CURTIS BEATER LOCK.

We have lately made arrangements with the Ward & Curtis Picker Beater Lock Company, to control the sale and introduction of their device for the prevention of accidents to the operatives on this class of machinery. This is a very serious matter, as a great number of operatives have been mutilated in various sections of the country from getting their hands

in contact with the revolving beaters. With the device above referred to, this class of accidents is absolutely prevented, because the beater cover can not be raised while the beater is revolving. Nor can the beater be started while the cover is up.

In the ordinary operation of the machines, the most fruitful cause of these accidents is that the covers are lifted in order to clean the beaters, and the operatives, from carelessness or

lack of knowledge, get their hands in contact with the revolving arms, which often can not be seen because of their rapid revolution.

It is easy to theorize that no sensible person will ever be so careless, but the same theory would apply to the operation of circular saws, which daily slice tons of human meat.

The actual records show sufficient evidence to prove the necessity of the device, and the slight expense allows no reasonable excuse for negligence. The State Inspectors of factories are, we understand, very strongly in favor of its adoption, and we have received testimonials and letters from many of them, saying that it is substantially a necessity. General Nye, of the American Mutual Liability Insurance Company, states that they have lost many thousands of dollars by beater accidents. Mr. John F. Tierney, State Inspector of Factories, states that they have had many serious accidents in his district, from employees getting their hands caught in the beaters.

The invention consists of a device to lock the beater-cover, that will prevent raising the cover until the beater is stopped and prevented from rotation. When the cover is dropped, it automatically re-sets the lock and liberates the beater. A slotted plate is applied to the beater shaft, an ingenious spring lock is fastened to the machine so as to co-operate with the same, and the beater cover is provided with a slight co-operating projection. These simple devices accomplish the desired result.

The Ward & Curtis people have received many strong endorsements of the device and several of the mills where they are in use have given us written testimonials of their efficiency. Mr. Barnes, Agent of the Pemberton Company, Lawrence, Mass., states that they are very much pleased with the safety device for beaters. Mr. William Evans, Agent of the Richard Borden Co., Fall River, Mass., states that "Our opinion of its merit will be found in the fact of our having purchased them for all our beaters." Mr. E. G. Childs, Agent of the Boston Duck Company, Bondsville, Mass., states that the beater lock fills a long felt want, and will prevent many serious accidents. Mr. H. H. Shumway, Treasurer of the Corr Mfg. Co., states: "We have applied them to all our beaters, out of respect for the safety of our employees." Mr. George E. Tucker, Agent of the Otis Company, Ware, Mass., states: "We find that your safety device accomplishes all that you claim for it, and we would not care to run our pickers without it." Mr. J. C. Smith, Supt. of the Chase Mills, Fall River, states: "We have your beater lock on all our pickers, and think that as a safety device, it is all you claim for it."

DETAILS OF BEATER ACCIDENTS.

The following are details of accidents reported during the year, taken from the records of the Department at the State House in Boston:

"Opened door of picker to remove some waste, when left hand was struck by beater, causing loss of one finger above second joint."

"Crawled under machine and put his hand into the beater. Right arm taken off near shoulder."

"Left hand injured by being caught in a beater of a lap machine."

"Lost right arm by raising cover of beater chamber, and putting arm in."

"Lost right arm by raising cover to beater, to remove some cotton."

"Lost left hand by raising cover to beater to free rolls which had become clogged."

"Lacerated one finger, by putting his hand in beater."

"Put his right hand in beater cage before machine had stopped, and lost thumb and first finger."

"Left thumb was struck by a revolving beater on opener machine."

"Was trying to clean some waste out of picker, when right thumb was caught by beater, and injured, requiring amputation."

Commonwealth of Massachusetts.

OFFICE OF THE
CHIEF OF THE DISTRICT POLICE,
STATE HOUSE.

Boston, Mass., Dec. 16, 1899.

TO THE DRAPER CO.,

SIRS:—In answer to your wishes for an endorsement of the benefits derived from the use of the safety device called a "beater lock for cotton pickers," I would say that I endorse it as one of the best safety devices ever placed on the market.

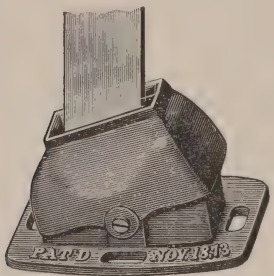
The model of this device was exhibited by Inspector Burfitt of this department at the thirteenth convention of the International Association of Factory Inspectors, held at the City of Quebec, Canada, August 29th, 30th and 31st, 1899.

Very truly yours,
Signed RUFUS R. WADE,
Chief of the
Massachusetts District Police.

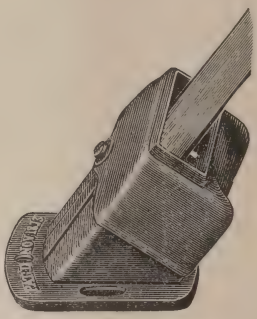
We have a few specialties of general mill utility that may be used in all departments.

WOOD'S PATENT BELT HOLE GUARDS.

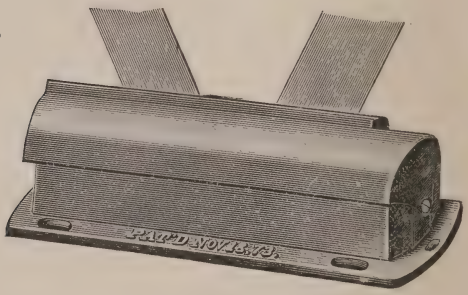
We have introduced thousands of the Belt Hole Guards, originally patented by Mr. B. L. Wood, and can furnish the best article of the kind ever made. Our patterns are varied to meet the requirements, and have no joints or edges to wear the belt.



FOR STRAIGHT BELTS.



FOR BEVELED BELTS.



FOR CROSSED BELTS.

Wood's Patent Belt Hole Guards are desirable for the following reasons:

1st. By the rotary movement of the covers the belt hole is much reduced in size, at least three-quarters in cross belt holes. To illustrate, a two-inch cross belt requires a hole about four inches wide by its spread, say six to ten inches in length. These guards reduce the hole to about three-fourths of an inch in width by about nine to ten inches in length, being a reduction in the size of the hole from thirty-two square inches to only six.

2d. The floor may be flooded, in case of fire, to the depth of two inches with no danger of the water running through the belt holes and injuring goods and machinery in the rooms below.

3d. In case of fire these guards prevent the flames from passing through the belt holes, either up or down, and are of the utmost importance in this particular.

4th. They prevent dirt, cotton, threads, waste, spools and other articles from passing through the belt holes into the lights, or the cards, or other machinery below.

5th. There is always a great quantity of imperceptible dust passing through the belt holes, following the current of air caused by the motion of the belt. These guards prevent them to a great extent.

6th. They very largely prevent the heat from passing from the lower to the upper room.

7th. They never require to be oiled, and will never clog up and stick.

8th. They prevent any twisting of the belt.

9th. The movement of the cover is so easy that there is no material friction or wear of the belt, it requiring but a slight touch of the belt as it moves from one pulley to another to carry the cover with it.

10th. The movable top keeps the belt square on the pulley, and prevents it from running part on the tight pulley and part on the loose pulley, as is often the case.

11th. They are highly recommended by Insurance Companies.

We like to trade with mills that think the best is none too good for them. An order for these Guards will place yours in that category.

DIRECTIONS FOR ORDERING.

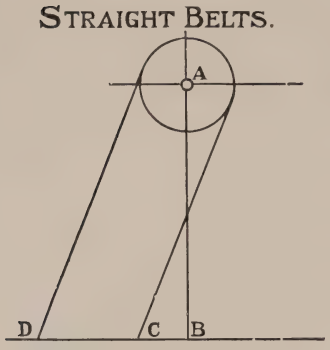
If care is used in following these directions, much trouble will be saved. Reference to the accompanying diagrams will make the matter plain.

If ready to give an order now fill in the blanks and return.

Ordered by.....

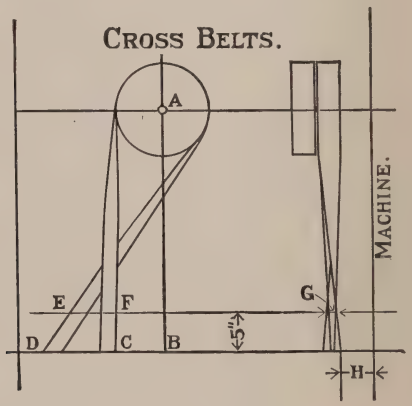
Date.....190 .....

FOR STRAIGHT BELTS—ANSWER THE FOLLOWING QUESTIONS:



No. of machines guards are required for.....
Width of Belt.....
Diameter of Pulley.....
Distance A to B.....
Distance B to C.....
Distance B to D.....
Distance C to D.....
Distance Belt is from machine when on pulley next to machine.....

FOR CROSSED BELTS—ANSWER THE FOLLOWING QUESTIONS:

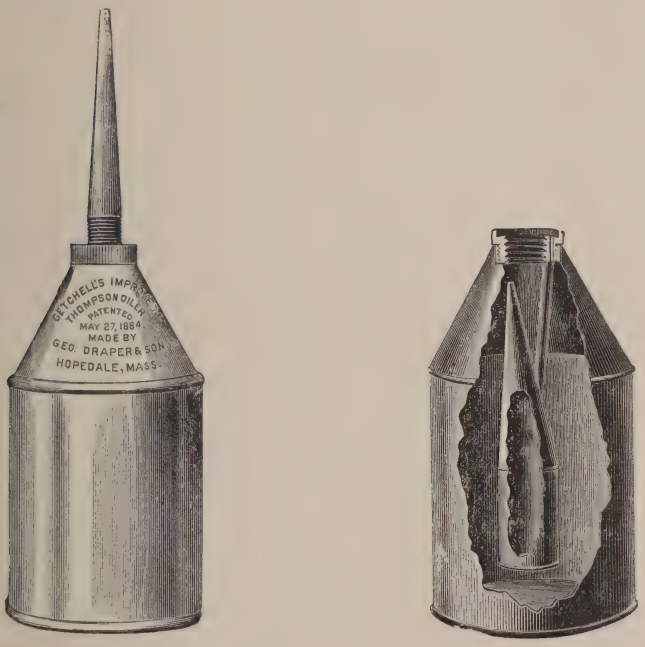


Number of machines guards are required for.....
Width of Belt.....
Distance A to B.....
Diameter of Pulley.....
Distance B to C.....
Distance B to D.....
Distance C to D.....
Distance F to E, (5 in. above floor.).....
Distance H, when belt is on pulley next to machine.....
Distance G, (5 in. above floor.).....

GETCHELL'S IMPROVED THOMPSON OIL-CAN.

We have been intimately connected with the manufacture of oil-cans for over forty years.

During the term of the Thompson patent we manufactured an oil-can that was not equalled for economy, convenience and durability; and in introducing the improvement of a removable air-chamber and vent-tube with a case-hardened delivery-tube, we have made the Getchell Improved Thompson Can superior to all others that we have any knowledge of. No other oil-can has been sold in such quantities as the Thompson of our make.



GETCHELL'S OIL CANS.

We stamp every can and guarantee it to be perfect.

Before concluding that a cheaper can is as good as ours, we ask for a trial in connection with any other in the market, feeling confident that our cans have no equal for economy in the use of oil, neatness and durability.

DIRECTIONS FOR ORDERING GETCHELL'S IMPROVED THOMPSON OIL-CANS.

Large	.	.	3¼	in. high,	2¾	in. diam.,	holding	3	gills.
Common	.	3	"	"	2½	"	"	"	2	"
Small	.	.	2⅜	"	"	2⅛	"	"	"	1	"

We distinguish the tubes by the size of the holes: that is, No. 19 has a hole No. 19 wire gauge; No. 20 has a hole No. 20 wire-gauge. Those most frequently wanted are Nos. 19, 20 and 21; but we make tubes with any size of hole to order.

Our common length of tube is 3¼ inches. Tubes of greater length we make to order.

Send for sample lot of cans.

A proper system of oiling will make a heavy cut in the repair bill. The better the oil can, the better the chance of intelligent use.

CARDING.

The card room as now constituted contains revolving flat cards, drawing frames, and coarse and fine roving frames. Many mills also still use the railway head and lap winder, and combing machines are becoming quite a common factor.

All the machinery in the carding room must be substantially set in place and accurately leveled. The floor under the machinery should be protected with galvanized iron having upturned edges. The cards require special attention in setting up and application of the card clothing. While there are many kinds of card clothing in use, there is probably little question as to which are the better grades. It is poor economy to use any other.

Cards should be properly ground before use. Plenty of time should be taken, and this job should be carefully supervised. The more accurately the card is made mechanically, the less will be the necessity for grinding, as it is in this first grinding, that all inequalities must be removed.

The revolving card of to-day is a high product of skill and accuracy, and requires intelligent management.

Railway heads and drawing frames require careful attention in setting up, as there are many nice adjustments to be made; evener belts must work right, top rolls be properly covered, drafts correctly arranged, and all moving parts lubricated and the dirty oil wiped off.

LANE TESTS.

During the summer of '95 when Gen. Draper was absent in Europe, we employed his secretary, Mr. Lane, in procuring records of actual results in cotton manufacture. He investigated three large Northern mills on prints and similar numbers, and we have tabulated his facts as follows. We do not name the mills for obvious reasons. It will be noticed that they vary in different departments. In some cases the single figures given are averaged from results that took weeks of observation. Six months continuous time was involved, and we think the results of sufficient importance to warrant reprinting.

CARDING.

	Revolving Flat Card 3 process Drawing.	Top Flat Breaker & Finisher Cards, 2 Process Drawing.	Revolving Flat Card, 2 Process Drawing.
Production of cards per day in lbs	150	50	125
Weight of lap on card in lbs	44	44	46
Dia. of lap in inches	17	17	17
Width of lap in inches	40	34	40
Lap lasts (hours-minutes)	2-40	7-45	3-50
Dia. of can in front of card or Railway Head, in inches	9½	17½	11½
Length of can in inches	36	36	36
	Hrs. Min.	Hrs. Min.	Hrs. Min.
Card fills can in	27		51
Railway head fills can in		20	
Coarse drawing empties can	2-34	2-	6-
Coarse drawing fills can	30	40 (15½ DIA. CAN)	72
Intermediate drawing empties can	2-39		
Intermediate drawing fills can.	30		
Fine drawing empties can	3-03	2-15	5-56
Fine drawing fills can	35	29 (11½ DIA. CAN.)	77
Slubber empties can	3-35	4-24	6-31
Slubber fills bobbin	1-04	1-15	1-13
Intermediate empties bobbin	6-50	6-43	7-40
Intermediate fills bobbin	1-49	1-51	2-29
Fine frame empties bobbin	17-00	17-	27-
Fine frame fills bobbin	3-17	2-52	4-49
DRAFTS—			
Railway head		4.	
Coarse drawing	5.21	3.62	4.75
Int. drawing	5.75		
Fine drawing	5.73	3.73	5.

CARDING.—Continued.

	Revolving Flat Card, 3 process Drawing.	Top Flat, Breaker & Finisher Cards, 2 Process Drawing.	Revolving Flat Card, 2 Process Drawing.
Slubber	3.88	3.88	5.13
Intermediate	5.47	5.33	5.46
Fine	7.20	6.36	6.67
HANKS PER POUND—			
Front of card	.13		.16
" " railway		.08	
" " coarse drawing	.12	.10	.13
" " intermediate "	.12		
" " fine "	.12	.13	.10
Slubber	.44	.49	.54
Intermediate	1.22	1.27	1.55
Fine	4.45	3.97	5.00
SIZE OF ROVING BOBBIN—			
Slubber	6 x 12	Same.	Same.
Intermediate	4½ x 9	5 x 10	5 x 10
Fine	3½ x 7	Same.	Same.
NO. OF HANKS ON BOBBIN—			
Slubber	1.31	1.21	1.41
Intermediate	1.22	1.78	2.68
Fine	2.67	2.18	3.62
Roving is doubled on intermediate and fine frames in all cases.			
BREAKAGE OF ENDS—			
On card, per day	1¼	5-12	.8 1-6
" coarse drawing	5	2	3
" intermediate drawing	1		
" fine	2	2	2
" 100 slubber spindles	48	79	137
" " intermediate "	49	34	50
" " fine "	39	28	19

SPINNING.

WARP FRAME.	Double Roving 1 5-8 Ring, 5 1-2 Traverse, No. 30.	Single Roving 1 5-8 Ring, 5 1-2 Traverse, No. 28.	Double Roving 1 3-4 Ring, 6 Traverse, No. 28.
Empties roving bobbin—hours	52-	25-	68-
Fills bobbin—hours-minutes	4-	3-49	6-
No. Hanks on bobbin	2.49	2.94	3.42
Draft on frame	13.37	7.44	11.20
Breakage of ends per 100 spindles per day.	41	63	118 new rings.

SPINNING.—Continued.

FILLING FRAME.	Single Roving, 1 1-4 Ring, No. 30.	Single Roving 1 5-16 ring, No. 36.	Double Roving 1 5-16 ring No. 36.
Empties roving bobbin—Hours-minutes	25-45	36-30	95-
Fills bobbin—hours-minutes	1-56	2-53	3-8
No. hanks on bobbin	1.56	1.82	1.56
Draft on frame	7.01	9.39	14.
Breakage of ends per 100 spindles per day	72	112	126 new rings.

MULE.		Single Roving No. 36.	
Empties roving bobbin—hours		39-	
Fills Cop—hours-minutes		2-40	
Hanks on cop		1.55	
Draft		9.27	
Breakage of ends per 100 spindles per day		167	

SPOOLING.

SPOOLER.	1 5-8 Ring 5 1-2 Traverse.	1 5-8 Ring 5 1-2 Traverse.	1 3-4 Ring 6 Traverse.
Empties bobbin—minutes	9	11	18
No. bobbins on spool	11	11	7
Breakage of ends per 100 spindles per day	179	185	272

WARPING.

WARPER.			
Fills beam—hours-minutes	8-	8-30	8-45
No. yards on beam	24,000	24,000	21.000
Weight of beam—lbs	400	359	392
No. ends on beam	410	360	437
Breakage of ends per beam	32	36	32

SLASHING.

Slasher.			
No. beams behind slasher	4	5	4
No. ends	1,784	1,800	1,760 16 twisted selvage ends.
Time to empty set of beams—hours-minutes	9-	10-	10-30
No. loom beams from set of warp beams	15	16	20
Cuts on loom beam	30	26	22
Yards per cut	48	54	46½
Distance between heads on loom beam	32	32	31½
Dia. of beam head	17	16	16

WEAVING.

Loom.			
Production of looms per day in cuts	1.02	.96	1.04
Length of cuts—yards	48	54	46½
Breakage of warp ends per loom per day	22	29	14
Breakage of yarn on filling bobbins in weaving per loom per day	5	5	9
Thin stripes per cut	3	2	1
Warp runs over one inch—per cut	12	19	2

Next table is of Breaks and Replacements in three mills per thousand spindles per day. This shows operations necessary on each machine that require hand labor. Breaks signify parting of the sliver or yarn in its journey to the can, bobbin, cop, spool or beam. On the loom it signifies warp breaks or breaks of filling yarn.

Replacements signify the hand operations required to renew the laps on cards, the cans on drawing and slubber, the roving on roving and spinning frames, and the bobbins on the spoolers:

	Breaks.	Replacements.	Breaks.	Replacements.	Breaks.	Replacements.
*Card	1.90	5.72	1.64	5.08	13.50	4.31
*Coarse drawing	6.18	32.17	1.49	19.46	5.17	22.41
*Int. "	1.29	29.60				
*Fine "	2.57	20.59	1.75	19.21	3.45	15.42
*Slubber	4.40	25.60	7.67	20.48	12.57	12.20
*Intermediate	13.30	79.28	8.50	74.50	14.31	74.31
*Fine	46.82	141.66	30.60	128.96	27.74	108.03
Warp spinning	410.	380.	630.	400.	1180.	300.
Filling "	720.	390.	1120.	270.	1260.	105.
Mule "			1670.	260.		
†Spooler	105.29	3921.76	130.37	3914.73	176.28	2160.08
†Warper	17.05		24.88		19.75	
†Slasher	.07		.23		.09	
*Loom	565.99		839.61		398.29	

†Figured per 1000 warp spindles.
*Figured on total number spindles.

We think it will pay any mill on similar numbers to take a test of their own machinery for comparison. There are some interesting deductions that can be made from these present tables. The large spinning ring and longer traverse evidently helps in doffing and spooling. The breakage of ends is greater but we think this is due to new rings rather than to larger rings. The extra breakage on the spooler is quite perceptible, but is more than overcome by the extra time a bobbin runs. It will be seen that in the third mill the warps are evidently not wound hard on the slasher, as there are quite a few less cuts per beam. This third mill, however, has quite a perceptible diminution of warp breaks on the loom, which may come from this. This low breakage is also probably due somewhat to the larger warp bobbins, giving less knots at the spooler.

RULES FOR CARDERS.

To determine the number of hanks or decimal parts of hanks to the pound for carding, drawing, slubbing, roving and yarn, according to a given number of yards reeled or measured:—

Multiply the number of yards by $8\frac{1}{3}$ and divide by their weight in grains; the quotient will be the hanks or decimal parts of hanks required

One yard of No. 1 roving or yarn weighs $8\frac{1}{3}$ grains.

To ascertain what number of yarn will be produced from a given drawing or sliver:—

Measure off a convenient number of yards of sliver, multiply this number by extent of drawing on roving and spinning heads, then multiply by $8\frac{1}{3}$ and divide by the weight in grains, which will give the number of yarn produced from the given sliver. *Example:* Take two yards of sliver weighing 20 grains, and suppose it is to be drawn 5 on roving and 10 on spinning.

$2\times5\times10\times8\frac{1}{3}=833.3,\div20=$No. 41.6, the number of yarn.

To determine what weight a given length of drawing, slubbing, roving or yarn should be to equal a given number of hanks or decimal parts of hanks:—

Multiply the given number of yards in length by $8\frac{1}{3}$ and divide by the number of hanks or decimal parts of hanks required; the quotient will be the weight, in grains, of the given length of drawing, roving or yarn.

To number the yarn produced from roving:—

Reel or measure off a convenient number of yards of roving; multiply this number by extent of drawing on spinning heads. This product multiplied by $8\frac{1}{3}$ and divided by the weight, will give the number of yarn which would be made from the roving. *Example:* Suppose 5 yards of roving weigh 20 grains, and the draught is 10. Then $5\times10\times8\frac{1}{3}=416.6,\div20=$ 20.8, the number of the yarn.

Given, the weight of lap from the picker, and draught and doublings from the card to the spinning frame: To find the weight at any given point and number of yarn that will be produced:—

Example: Weight of lap, 9 oz.; single carding, draught, 100; railway head, draught, 4; doublings, 14; first drawing, draught, 4, doublings, 3; second drawing, draught, $4\frac{1}{2}$, doublings, 3; slubbers, draught, 4; intermediates, doublings, 2, draught, $5\frac{1}{2}$; fine frames, doublings, 2, draught, $6\frac{1}{2}$; spinning frames, draught, $7\frac{1}{2}$; allowance for flyings and strippings in carding, 12 per cent.; allowance for take up by twist in slubbing, intermediate, fine and spinning frames, $\frac{1}{31}$ each, or about $\frac{1}{7}$ in all; with the following result:—

$9\times437.5=3937.5$ grains in 1 yard of lap.

$3937.5\div100=39.375$ grains in 1 yard after leaving card, were there no loss.

$39.375\times.88=34.65$ grains in 1 yard after deducting 12 per cent. for flyings and strippings.

$34.65\times14\div4=121.27$ grains in 1 yard after leaving railway head.

$121.27\times3\div4=90.95$ grains in 1 yard after leaving first drawing.

$90.95\times3\div4\frac{1}{2}=60.63$ grains in 1 yard after leaving second drawing.

$60.63\div4\times\frac{3}{4}\frac{3}{2}\times12=187.76$ grains in 12 yards after leaving slubbers.

$187.76\times2\div5\frac{1}{2}\times\frac{3}{3}\frac{3}{1}=70.48$ grains in 12 yards after leaving intermediates.

$70.48\times2\div6\frac{1}{2}\times\frac{3}{3}\frac{3}{1}=22.39$ grains in 12 yards after leaving fine frames.

$22.39\div7\frac{1}{2}\times\frac{3}{3}\frac{3}{1}=3.081$ grains in 12 yards after leaving spinning frames.

$3.081\times70=215.67$ grains in 1 hank after leaving spinning frames.

$7000\div215.67=32.45$ number of yarn.

Rule: Multiply the weight in ounces of one yard of lap by 437.5 (grains in an avoirdupois ounce), to reduce to grains; divide by draught of card and multiply by $\frac{88}{100}$ to give weight with allowance for loss in carding; for each successive process, multiply by the doublings and divide by the draught, and on slubbing, intermediate, fine and spinning frames multiply

by $\frac{32}{31}$ to allow for increase in weight by twist; at slubbers multiply by 12 for a common number of yards to weigh; and at spinning frames by 70, to give weight per hank, and divide 7000 by the product to determine the number of yarn.

NOTE.—Roving and yarn contract in twisting, and an allowance should be made for this in all computations for a twisted product. This allowance will vary with the number of the yarn and amount of twist put in.

To find the weight of lap required to produce a given number of yarn, and also the weight at any given point, the draught and doublings being known:—

Example: Suppose the draught and doublings the same as in the preceding, and we wish to produce No. 32.45 yarn.

7000÷32.45=215.71 grains per hank.

215.71÷70=3.081 grains per 12 yards.

$3.081\times\frac{31}{32}\times7\frac{1}{2}$=22.39 grains per 12 yards after leaving fine frames.

$22.39\times\frac{31}{32}\times6\frac{1}{2}\div2$=70.49 grains per 12 yards after leaving intermediates.

$70.49\times\frac{31}{32}\times5\frac{1}{2}\div2$=187.78 grains per 12 yards after leaving slubbers.

$187.78\times\frac{31}{32}\times4\div12$=60.63 grains per 1 yard after leaving second drawing.

$60.63\times4\frac{1}{2}\div3$=90.95 grains per 1 yard after leaving first drawing.

90.95×4÷3=121.27 grains per 1 yard after leaving railway-head.

121.27×4÷14=34.65 grains per 1 yard after leaving card.

$34.65\times100\times\frac{100}{885}$=3937.5 grains per 1 yard of lap.

3937.5÷437.5=9 ounces per 1 yard of lap.

Rule: Divide 7000 by the number of yarn desired, and that quotient by 70 to give the weight of 12 yards; multiply by the draught of each machine and divide by the doublings; for spinning, fine, intermediate and slubbing frames multiply by $\frac{32}{31}$ to allow for decrease in weight by taking out the twist; at second drawing divide by 12 to give the weight of one yard; multiply by $\frac{100}{885}$ at the card to allow for loss, and divide by 437 5 to give weight of lap required in ounces.

The following tables for numbering roving have been extended and adapted for numbering from weights in tenths of grains. Twist in all cases is 1.20 times the square root of the number.

In the earlier editions of our catalogues, we grouped the various departments in turn, illustrating our machinery for each process, and following up with rules and tables. In view of the time and trouble for re-arrangement of each edition on this plan, we shall now group all our standard matter together so that changes in the latter portion of the book can be more easily made in following editions.

TABLE FOR NUMBERING ROVING.

12 yds. weigh grains.	Hank roving.	12 yds. weigh grains.	Hank roving.	12 yds. weigh grains	Hank roving.	12 yds. weigh grains.	Hank roving.	12 yds. weigh grains.	Hank roving.
1.	100.00	**9.**	11.11	**16.**	6.25	**23.**	4.35	**30.**	3.33
.2	83.33	.1	10.99	.1	6.21	.1	4.35	.1	3.32
.4	71.43	.2	10.87	.2	6.17	.2	4.31	.2	3.31
.6	62.50	.3	10.75	.3	6.13	.3	4.29	.3	3.30
.8	55.56	.4	10.64	.4	6.10	.4	4.27	.4	3.29
2.	50.00	.5	10.53	.5	6.06	.5	4.26	.5	3.28
.2	45.45	.6	10.42	.6	6.02	.6	4.24	.6	3.27
.4	41.67	.7	10.31	.7	5.99	.7	4.22	.7	3.26
.6	38.46	.8	10.20	.8	5.95	.8	4.20	.8	3.25
.8	35.71	.9	10.10	.9	5.92	.9	4.18	.9	3.24
3.	33.33	**10.**	10.00	**17.**	5.88	**24.**	4.17	**31**	3.23
.1	32.26	.1	9.90	.1	5.85	.1	4.15	.1	3.22
.2	31.25	.2	9.80	.2	5.81	.2	4.13	.2	3.21
.3	30.30	.3	9.71	.3	5.78	.3	4.12	.3	3.19
.4	29.41	.4	9.62	.4	5.75	.4	4.10	.4	3.18
.5	28.57	.5	9.52	.5	5.71	.5	4.08	.5	3.17
.6	27.78	.6	9.43	.6	5.68	.6	4.07	.6	3.16
.7	27.03	.7	9.35	.7	5.65	.7	4.05	.7	3.15
.8	26.32	.8	9.26	.8	5.62	.8	4.03	.8	3.14
.9	25.64	.9	9.17	.9	5.59	.9	4.02	.9	3.13
4.	25.00	**11.**	9.09	**18.**	5.56	**25.**	4.00	**32.**	3.12
.1	24.39	.1	9.01	.1	5.52	.1	3.98	.1	3.12
.2	23.81	.2	8.93	.2	5.49	.2	3.97	.2	3.11
.3	23.26	.3	8.85	.3	5.46	.3	3.95	.3	3.10
.4	22.73	.4	8.77	.4	5.43	.4	3.94	.4	3.09
.5	22.22	.5	8.70	.5	5.41	.5	3.92	.5	3.08
.6	21.74	.6	8.62	.6	5.38	.6	3.91	.6	3.07
.7	21.28	.7	8.55	.7	5.35	.7	3.89	.7	3.06
.8	20.83	.8	8.47	.8	5.32	.8	3.88	.8	3.05
.9	20.41	.9	8.40	.9	5.29	.9	3.86	.9	3.04
5.	20.00	**12.**	8.33	**19.**	5.26	**26.**	3.85	**33.**	3.03
.1	19.61	.1	8.26	.1	5.24	.1	3.83	.1	3.02
.2	19.23	.2	8.20	.2	5.21	.2	3.82	.2	3.01
.3	18.87	.3	8.13	.3	5.18	.3	3.80	.3	3.00
.4	18.52	.4	8.06	.4	5.15	.4	3.79	.4	2.99
.5	18.18	.5	8.00	.5	5.13	.5	3.77	.5	2.99
.6	17.86	.6	7.94	.6	5.10	.6	3.76	.6	2.98
.7	17.54	.7	7.87	.7	5.08	.7	3.75	.7	2.97
.8	17.24	.8	7.81	.8	5.05	.8	3.73	.8	2.96
.9	16.95	.9	7.75	.9	5.03	.9	3.72	.9	2.95
6.	16.67	**13.**	7.69	**20.**	5.00	**27.**	3.70	**34.**	2.94
.1	16.39	.1	7.63	.1	4.98	.1	3.69	.1	2.93
.2	16.13	.2	7.58	.2	4.95	.2	3.68	.2	2.92
.3	15.87	.3	7.52	.3	4.93	.3	3.66	.3	2.92
.4	15.62	.4	7.46	.4	4.90	.4	3.65	.4	2.91
.5	15.38	.5	7.41	.5	4.88	.5	3.64	.5	2.90
.6	15.15	.6	7.35	.6	4.85	.6	3.62	.6	2.89
.7	14.93	.7	7.30	.7	4.83	.7	3.61	.7	2.88
.8	14.71	.8	7.25	.8	4.81	.8	3.60	.8	2.87
.9	14.49	.9	7.19	.9	4.78	.9	3.58	.9	2.87
7.	14.29	**14.**	7.14	**21**	4.76	**28.**	3.57	**35.**	2.86
.1	14.08	.1	7.09	.1	4.74	.1	3.56	.1	2.85
.2	13.89	.2	7.04	.2	4.72	.2	3.55	.2	2.84
.3	13.70	.3	6.99	.3	4.69	.3	3.53	.3	2.83
.4	13.51	.4	6.94	.4	4.67	.4	3.52	.4	2.82
.5	13.33	.5	6.90	.5	4.65	.5	3.51	.5	2.82
.6	13.16	.6	6.85	.6	4.63	.6	3.50	.6	2.81
.7	12.99	.7	6.80	.7	4.61	.7	3.49	.7	2.80
.8	12.82	.8	6.76	.8	4.59	.8	3.47	.8	2.79
.9	12.66	.9	6.71	.9	4.57	.9	3.46	.9	2.79
8.	12.50	**15.**	6.67	**22.**	4.55	**29.**	3.45	**36.**	2.78
.1	12.35	.1	6.62	.1	4.52	.1	3.44	.1	2.77
.2	12.20	.2	6.58	.2	4.50	.2	3.42	.2	2.76
.3	12.05	.3	6.54	.3	4.48	.3	3.41	.3	2.75
.4	11.90	.4	6.49	.4	4.46	.4	3.40	.4	2.75
.5	11.76	.5	6.45	.5	4.44	.5	3.39	.5	2.74
.6	11.63	.6	6.41	.6	4.42	.6	3.38	.6	2.73
.7	11.49	.7	6.37	.7	4.41	.7	3.37	.7	2.72
.8	11.36	.8	6.33	.8	4.39	.8	3.36	.8	2.72
.9	11.24	.9	6.29	.9	4.37	.9	3.34	.9	2.71

TABLE FOR NUMBERING ROVING.

12 yds. weigh grains.	Hank roving.	12 yds. weigh grains.	Hank roving.	12 yds. weigh grains.	Hank roving.	12 yds. weigh grains.	Hank roving.	12 yds. weigh grains.	Hank roving
37.	2.70	**48.**	2 08	**65**	1.54	**100**	1.00	**190**	.53
.1	2.70	.2	2.07	.5	1.53	101	.99	192	.52
.2	2.69	.4	2.07	66.	1.52	102	.98	194	.52
.3	2.68	.6	2.06	.5	1.50	103	.97	196	.51
.4	2.67	.8	2.05	67	1.49	104	.96	198	.51
.5	2.67	**49**	2.04	.5	1.48	105	.95	**200**	.50
.6	2.66	.2	2.03	68	1.47	106	.94	202	.50
.7	2.65	.4	2.02	.5	1.46	107	.93	204	.49
.8	2.65	.6	2.02	69.	1.45	108	.93	206	.49
.9	2.64	.8	2.01	.5	1.44	109	.92	208	.48
38.	2.63	**50**	2.00	**70.**	1.43	**110**	.91	**210**	.48
.1	2.62	.2	1.99	.5	1.42	111	.90	212	.47
.2	2.62	.4	1.98	71.	1.41	112	.89	214	.47
.3	2.61	.6	1.98	.5	1.40	113	.88	216	.46
.4	2.60	.8	1.97	72.	1.39	114	.88	218	.46
.5	2.60	**51**	1.96	.5	1.38	115	.87	220	.45
.6	2.59	.2	1.95	73.	1.37	116	.86	222	.45
.7	2.58	.4	1.95	.5	1.36	117	.85	224	.45
.8	2.58	.6	1.94	74.	1.35	118	.85	226	.44
.9	2.57	.8	1.93	.5	1.34	119	.84	228	.44
39.	2.56	**52.**	1.92	**75.**	1.33	**120**	.83	**230**	.43
.1	2.56	.2	1.92	.5	1.32	121	.83	235	.43
.2	2.55	.4	1.91	76	1.32	122	.82	240	.42
.3	2.54	.6	1.90	.5	1.31	123	.81	245	.41
.4	2.54	.8	1.89	77.	1.30	124	.81	250	.40
.5	2.53	**53**	1.89	.5	1.29	125	.80	255	.39
.6	2.53	.2	1.88	78.	1.28	126	.79	260	.38
.7	2.52	.4	1.87	.5	1.27	127	.79	265	.38
.8	2.51	.6	1.87	79.	1.27	128	.78	270	.37
.9	2.51	.8	1.86	.5	1.26	129	.78	275	.36
40.	2.50	**54.**	1.85	**80.**	1.25	**130**	.77	**280**	.36
.2	2.49	.2	1.85	.5	1.24	131	.76	285	.35
.4	2.48	.4	1.84	81.	1.23	132	.76	290	.34
.6	2.46	.6	1.83	.5	1.23	133	.75	295	.34
.8	2.45	.8	1.82	82.	1.22	134	.75	300	.33
41.	2.44	**55.**	1.82	.5	1.21	135	.74	305	.33
.2	2.43	.2	1.81	83.	1.20	136	.74	310	.32
.4	2.42	.4	1.81	.5	1.20	137	.73	315	.32
.6	2.40	.6	1.80	84.	1.19	138	.72	320	.31
.8	2.39	.8	1.79	.5	1.18	139	.72	330	.30
42.	2.38	**56.**	1.79	**85.**	1.18	**140**	.71	**340**	.29
.2	2.37	.2	1.78	.5	1.17	141	.71	350	.29
.4	2.36	.4	1.77	86.	1.16	142	.70	360	.28
.6	2.35	.6	1.77	.5	1.16	143	.70	370	.27
.8	2.34	.8	1.76	87.	1.15	144	.69	380	.26
43.	2.33	**57.**	1.75	.5	1.14	145	.69	390	.26
.2	2.31	.2	1.75	88.	1.14	146	.68	400	.25
.4	2.30	.4	1.74	.5	1.13	147	.68	410	.24
.6	2.29	.6	1.74	89.	1.12	148	.68	420	.24
.8	2.28	.8	1.73	.5	1.12	149	.67	430	.23
44.	2.27	**58.**	1.72	**90.**	1.11	**150**	.67	**440**	.23
.2	2.26	.2	1.72	.5	1.10	152	.66	450	.22
.4	2.25	.4	1.71	91.	1.10	154	.65	460	.22
.6	2.24	.6	1.71	.5	1.09	156	.64	470	.21
.8	2.23	.8	1.70	92.	1.09	158	.63	480	.21
45.	2.22	**59.**	1.69	.5	1.08	**160**	.62	490	.20
.2	2.21	.2	1.69	93.	1.08	162	.62	500	.20
.4	2.20	.4	1.68	.5	1.07	164	.61	525	.19
.6	2.19	.6	1.68	94.	1.06	166	.60	550	.18
.8	2.18	.8	1.67	.5	1.06	168	.60	575	.17
46.	2.17	**60**	1.67	**95.**	1.05	**170**	.59	**600**	.17
.2	2.16	.5	1.65	.5	1.05	172	.58	625	.16
.4	2.16	61.	1.64	96.	1.04	174	.57	650	.15
.6	2.15	.5	1.63	.5	1.04	176	.57	675	.15
.8	2.14	62.	1.61	97.	1.03	178	.56	700	.14
47.	2.13	.5	1.60	.5	1.03	**180**	.56	725	.14
.2	2.12	63.	1.59	98.	1.02	182	.55	775	.13
.4	2.11	.5	1.57	.5	1.02	184	.54	825	.12
.6	2.10	64.	1.56	99.	1.01	186	.54	900	.11
.8	2.09	.5	1.55	.5	1.01	188	.53	1000	.10

TWIST OF ROVING.

Hank roving.	Square root.	Twist, 1.2 × sq. root.	Hank roving.	Square root.	Twist, 1.2 × sq. root.	Hank roving.	Square root.	Twist, 1.2 × sq. root.	Hank roving.	Square root.	Twist, 1.2 × sq. root.
.10	.316	.38	**.80**	.894	1.07	**2.20**	1.483	1.78	**4.32**	2.078	2.49
.11	.332	.40	.82	.906	1.09	2.22	1.490	1.79	4.36	2.088	2.51
.12	.346	.41	.84	.917	1.10	2.25	1.500	1.80	4.40	2.098	2.52
.13	.361	.43	.86	.927	1.11	2.28	1.510	1.81	4.44	2.107	2.53
.14	.374	.45	.88	.938	1.13	2.31	1.520	1.82	4.48	2.117	2.54
.15	.387	.46	.90	.949	1.14	2.34	1.530	1.84	4.52	2.126	2.55
.16	.400	.48	.92	.959	1.15	2.37	1.539	1.85	4.56	2.135	2.56
.17	.412	.49	.94	.970	1.16	2.40	1.549	1.86	4.60	2.145	2.57
.18	.424	.51	.96	.980	1.18	2.43	1.559	1.87	4.64	2.154	2.58
.19	.436	.52	.98	.990	1.19	2.46	1.568	1.88	4.68	2.163	2.60
.20	.447	.54	**1.00**	1.000	1.20	**2.49**	1.578	1.89	**4.72**	2.173	2.61
.21	.458	.55	1.02	1.010	1.21	2.52	1.587	1.90	4.76	2.182	2.62
.22	.469	.56	1.04	1.020	1.22	2.55	1.597	1.92	4.80	2.191	2.63
.23	.480	.58	1.06	1.030	1.24	2.58	1.606	1.93	4.84	2.200	2.64
.24	.490	.59	1.08	1.039	1.25	2.61	1.616	1.94	4.88	2.209	2.65
.25	.500	.60	1.10	1.049	1.26	2.64	1.625	1.95	4.92	2.218	2.66
.26	.510	.61	1.12	1.058	1.27	2.67	1.634	1.96	4.96	2.227	2.67
.27	.520	.62	1.14	1.068	1.28	2.70	1.643	1.97	5.00	2.236	2.68
.28	.529	.63	1.16	1.077	1.29	2.73	1.652	1.98	5.04	2.245	2.69
.29	.539	.65	1.18	1.086	1.30	2.76	1.661	1.99	5.08	2.254	2.70
.30	.548	.66	**1.20**	1.095	1.31	**2.79**	1.670	2.00	**5.12**	2.263	2.72
.31	.557	.67	1.22	1.105	1.33	2.82	1.679	2.01	5.16	2.272	2.73
.32	.566	.68	1.24	1.114	1.34	2.85	1.688	2.03	5.20	2.280	2.74
.33	.574	.69	1.26	1.122	1.35	2.88	1.697	2.04	5.24	2.289	2.75
.34	.583	.70	1.28	1.131	1.36	2.91	1.706	2.05	5.28	2.298	2.76
.35	.592	.71	1.30	1.140	1.37	2.94	1.715	2.06	5.32	2.307	2.77
.36	.600	.72	1.32	1.149	1.38	2.97	1.723	2.07	5.36	2.315	2.78
.37	.608	.73	1.34	1.158	1.39	3.00	1.732	2.08	5.40	2.324	2.79
.38	.616	.74	1.36	1.166	1.40	3.03	1.741	2.09	5.44	2.332	2.80
.39	.624	.75	1.38	1.175	1.41	3.06	1.749	2.10	5.48	2.341	2.81
.40	.632	.76	1.40	1.183	1.42	**3.09**	1.758	2.11	**5.52**	2.349	2.82
.41	.640	.77	1.42	1.192	1.43	3.12	1.766	2.12	5.56	2.358	2.83
.42	.648	.78	1.44	1.200	1.44	3.15	1.775	2.13	5.60	2.366	2.84
.43	.656	.79	1.46	1.208	1.45	3.18	1.783	2.14	5.64	2.375	2.85
.44	.663	.80	1.48	1.217	1.46	3.21	1.792	2.15	5.68	2.383	2.86
.45	.671	.80	1.50	1.225	1.47	3.24	1.800	2.16	5.72	2.392	2.87
.46	.678	.81	1.52	1.233	1.48	3.27	1.808	2.17	5.76	2.400	2.88
.47	.686	.82	1.54	1.241	1.49	3.30	1.817	2.18	5.80	2.408	2.89
.48	.693	.83	1.56	1.249	1.50	3.33	1.825	2.19	5.84	2.416	2.90
.49	.700	.84	1.58	1.257	1.51	3.36	1.833	2.20	5.88	2.425	2.91
.50	.707	.85	**1.60**	1.265	1.52	**3.39**	1.841	2.21	**5.92**	2.433	2.92
.51	.714	.86	1.62	1.273	1.53	3.42	1.849	2.22	5.96	2.441	2.93
.52	.721	.87	1.64	1.281	1.54	3.45	1.857	2.23	6.00	2.449	2.94
.53	.728	.87	1.66	1.288	1.55	3.48	1.865	2.24	6.04	2.458	2.95
.54	.735	.88	1.68	1.296	1.56	3.51	1.873	2.25	6.08	2.466	2.96
.55	.742	.89	1.70	1.304	1.56	3.54	1.881	2.26	6.12	2.474	2.97
.56	.748	.90	1.72	1.311	1.57	3.57	1.889	2.27	6.16	2.482	2.98
.57	.755	.91	1.74	1.319	1.58	3.60	1.897	2.28	6.20	2.490	2.99
.58	.762	.91	1.76	1.327	1.59	3.63	1.905	2.29	6.24	2.498	3.00
.59	.768	.92	1.78	1.334	1.60	3.66	1.913	2.30	6.28	2.506	3.01
.60	.775	.93	**1.80**	1.342	1.61	**3.69**	1.921	2.31	**6.32**	2.514	3.02
.61	.781	.94	1.82	1.349	1.62	3.72	1.929	2.31	6.36	2.522	3.03
.62	.787	.94	1.84	1.356	1.63	3.75	1.936	2.32	6.40	2.530	3.04
.63	.794	.95	1.86	1.364	1.64	3.78	1.944	2.33	6.44	2.538	3.05
.64	.800	.96	1.88	1.371	1.65	3.81	1.952	2.34	6.48	2.546	3.05
.65	.806	.97	1.90	1.378	1.65	3.84	1.960	2.35	6.52	2.553	3.06
.66	.812	.97	1.92	1.386	1.66	3.87	1.967	2.36	6.56	2.561	3.07
.67	.819	.98	1.94	1.393	1.67	3.90	1.975	2.37	6.60	2.569	3.08
.68	.825	.99	1.96	1.400	1.68	3.93	1.982	2.38	6.64	2.577	3.09
.69	.831	1.00	1.98	1.407	1.69	3.96	1.990	2.39	6.68	2.585	3.10
.70	.837	1.00	**2.00**	1.414	1.70	**3.99**	1.997	2.40	**6.72**	2.592	3.11
.71	.843	1.01	2.02	1.421	1.71	4.02	2.005	2.41	6.76	2.600	3.12
.72	.849	1.02	2.04	1.428	1.71	4.05	2.012	2.41	6.80	2.608	3.13
.73	.854	1.02	2.06	1.435	1.72	4.08	2.020	2.42	6.84	2.615	3.14
.74	.860	1.03	2.08	1.442	1.73	4.11	2.027	2.43	6.88	2.623	3.15
.75	.866	1.04	2.10	1.449	1.74	4.14	2.035	2.44	6.92	2.631	3.16
.76	.872	1.05	2.12	1.456	1.75	4.17	2.042	2.45	6.96	2.638	3.17
.77	.877	1.05	2.14	1.463	1.76	4.20	2.049	2.46	7.00	2.646	3.17
.78	.883	1.06	2.16	1.470	1.76	4.23	2.057	2.47	7.04	2.653	3.18
.79	.889	1.07	2.18	1.476	1.77	4.26	2.064	2.48	7.08	2.661	3.19

TWIST OF ROVING.

Hank roving.	Square root.	Twist, 1.2 × sq. root.	Hank roving.	Square root.	Twist, 1.2 × sq. root.	Hank roving.	Square root.	Twist, 1.2 × sq. root.	Hank roving.	Square root	Twist, 1.2 × sq. root.
7.10	2.665	3.20	10.62	3.259	3.91	14.84	3.852	4.62	19.76	4.445	5.33
7.15	2.674	3.21	10.68	3.268	3.92	14.91	3.861	4.63	19.84	4.454	5.35
7.20	2.683	3.22	10.74	3.277	3.93	14.98	3.870	4.64	19.92	4.463	5.36
7.25	2.693	3.23	10.80	3.286	3.94	15.05	3.879	4.66	20.00	4.472	5.37
7.30	2.702	3.24	10.86	3.295	3.95	15.12	3.888	4.67	20.08	4.481	5.38
7.35	2.711	3.25	10.92	3.305	3.97	15.19	3.897	4.68	20.16	4.490	5.39
7.40	2.720	3.26	10.98	3.314	3.98	15.26	3.906	4.69	20.24	4.499	5.40
7.45	2.729	3.28	11.04	3.323	3.99	15.33	3.915	4.70	20.32	4.508	5.41
7.50	2.739	3.29	**11.10**	3.332	4.00	**15.40**	3.924	4.71	**20.40**	4.517	5.42
7.55	2.748	3.30	11.16	3.341	4.01	15.47	3.933	4.72	20.48	4.525	5.43
7.60	2.757	3.31	11.22	3.350	4.02	15.54	3.942	4.73	20.56	4.534	5.44
7.65	2.766	3.32	11.28	3.359	4.03	15.61	3.951	4.74	20.64	4.543	5.45
7.70	2.775	3.33	11.34	3.367	4.04	15.68	3.960	4.75	20.72	4.552	5.46
7.75	2.784	3.34	11.40	3.376	4.05	15.75	3.969	4.76	20.80	4.561	5.47
7.80	2.793	3.35	11.46	3.385	4.06	15.82	3.977	4.77	20.88	4.569	5.48
7.85	2.802	3.36	11.52	3.394	4.07	15.89	3.986	4.78	20.96	4.578	5.49
7.90	2.811	3.37	11.58	3.403	4.08	15.96	3.995	4.79	21.04	4.587	5.50
7.95	2.820	3.38	11.64	3.412	4.09	16.03	4.004	4.80	21.12	4.596	5.51
8.00	2.828	3.39	**11.70**	3.421	4.10	**16.10**	4.012	4.81	**21.20**	4.604	5.52
8.05	2.837	3.40	11.76	3.429	4.12	16.17	4.021	4.83	21.28	4.613	5.54
8.10	2.846	3.42	11.82	3.438	4.13	16.24	4.030	4.84	21.36	4.622	5.55
8.15	2.855	3.43	11.88	3.447	4.14	16.31	4.039	4.85	21.44	4.630	5.56
8.20	2.864	3.44	11.94	3.455	4.15	16.38	4.047	4.86	21.52	4.639	5.57
8.25	2.872	3.45	12.00	3.464	4.16	16.45	4.056	4.87	21.60	4.648	5.58
8.30	2.881	3.46	12.06	3.473	4.17	16.52	4.064	4.88	21.68	4.656	5.59
8.35	2.890	3.47	12.12	3.481	4.18	16.59	4.073	4.89	21.76	4.665	5.60
8.40	2.898	3.48	12.18	3.490	4.19	16.66	4.082	4.90	21.84	4.673	5.61
8.45	2.907	3.49	12.24	3.499	4.20	16.73	4.090	4.91	21.92	4.682	5.62
8.50	2.915	3.50	**12.30**	3.507	4.21	**16.80**	4.099	4.92	**22.00**	4.690	5.63
8.55	2.924	3.51	12.36	3.516	4.22	16.87	4.107	4.93	22.08	4.699	5.64
8.60	2.933	3.52	12.42	3.524	4.23	16.94	4.116	4.94	22.16	4.707	5.65
8.65	2.941	3.53	12.48	3.533	4.24	17.01	4.124	4.95	22.24	4.716	5.66
8.70	2.950	3.54	12.54	3.541	4.25	17.08	4.133	4.96	22.32	4.724	5.67
8.75	2.958	3.55	12.60	3.550	4.26	17.15	4.141	4.97	22.40	4.733	5.68
8.80	2.966	3.56	12.66	3.558	4.27	17.22	4.150	4.98	22.48	4.741	5.69
8.85	2.975	3.57	12.72	3.567	4.28	17.29	4.158	4.99	22.56	4.750	5.70
8.90	2.983	3.58	12.78	3.575	4.29	17.36	4.167	5.00	22.64	4.758	5.71
8.95	2.992	3.59	12.84	3.583	4.30	17.43	4.175	5.01	22.72	4.767	5.72
9.00	3.000	3.60	**12.90**	3.592	4.31	**17.50**	4.183	5.02	**22.80**	4.775	5.73
9.05	3.008	3.61	12.96	3.600	4.32	17.57	4.192	5.03	22.88	4.783	5.74
9.10	3.017	3.62	13.02	3.608	4.33	17.64	4.200	5.04	22.96	4.792	5.75
9.15	3.025	3.63	13.08	3.617	4.34	17.71	4.208	5.05	23.04	4.800	5.76
9.20	3.033	3.64	13.14	3.625	4.35	17.78	4.216	5.06	23.12	4.808	5.77
9.25	3.041	3.65	13.20	3.633	4.36	17.85	4.225	5.07	23.20	4.817	5.78
9.30	3.050	3.66	13.26	3.641	4.37	17.92	4.233	5.08	23.28	4.825	5.79
9.35	3.058	3.67	13.32	3.650	4.38	17.99	4.241	5.09	23.36	4.833	5.80
9.40	3.066	3.68	13.38	3.658	4.39	18.06	4.250	5.10	23.44	4.841	5.81
9.45	3.074	3.69	13.44	3.666	4.40	18.13	4.258	5.11	23.52	4.850	5.82
9.50	3.082	3.70	**13.50**	3.674	4.41	**18.20**	4.266	5.12	**23.60**	4.858	5.83
9.55	3.090	3.71	13.56	3.682	4.42	18.27	4.274	5.13	23.68	4.866	5.84
9.60	3.098	3.72	13.62	3.691	4.43	18.34	4.283	5.14	23.76	4.874	5.85
9.65	3.106	3.73	13.68	3.699	4.44	18.41	4.291	5.15	23.84	4.883	5.86
9.70	3.114	3.74	13.74	3.707	4.45	18.48	4.299	5.16	23.92	4.891	5.87
9.75	3.122	3.75	13.80	3.715	4.46	18.55	4.307	5.17	24.00	4.899	5.88
9.80	3.130	3.76	13.86	3.723	4.47	18.62	4.315	5.18	24.08	4.907	5.89
9.85	3.138	3.77	13.92	3.731	4.48	18.69	4.323	5.19	24.16	4.915	5.90
9.90	3.146	3.78	13.98	3.739	4.49	18.76	4.331	5.20	24.24	4.923	5.91
9.95	3.154	3.79	14.04	3.747	4.50	18.83	4.339	5.21	24.32	4.932	5.92
10.00	3.162	3.79	**14.10**	3.755	4.51	**18.90**	4.347	5.22	**24.40**	4.940	5.93
10.05	3.170	3.80	14.16	3.763	4.52	18.97	4.355	5.23	24.48	4.948	5.94
10.10	3.178	3.81	14.22	3.771	4.53	19.04	4.363	5.24	24.56	4.956	5.95
10.15	3.186	3.82	14.28	3.779	4.53	19.11	4.371	5.25	24.64	4.964	5.96
10.20	3.194	3.83	14.34	3.787	4.54	19.18	4.379	5.26	24.72	4.972	5.97
10.25	3.202	3.84	14.40	3.795	4.55	19.25	4.387	5.26	24.80	4.980	5.98
10.30	3.209	3.85	14.46	3.803	4.56	19.32	4.395	5.27	24.88	4.988	5.99
10.35	3.217	3.86	14.52	3.811	4.57	19.39	4.403	5.28	24.96	4.996	6.00
10.40	3.225	3.87	14.58	3.818	4.58	19.46	4.411	5.29	25.04	5.004	6.00
10.45	3.233	3.88	14.64	3.826	4.59	19.53	4.419	5.30	25.12	5.012	6.01
10.50	3.240	3.89	14.70	3.834	4.60	19.60	4.427	5.31	25.20	5.020	6.02
10.55	3.248	3.90	14.76	3.842	4.61	19.67	4.435	5.32	25.28	5.028	6.03

RELATIVE AND ACTUAL HUMIDITY.

The condition of the air with respect to the vapor of water it contains is called its humidity. The degree of humidity is expressed as a per centage of the maximum quantity of vapor the air will contain at the temperature, and this per centage is termed its relative humidity. The actual humidity is the weight in grains per cubic foot of the vapor in the air. Increase of temperature increases the capacity of the air to hold moisture. The mean relative humidity of the air at Boston, Mass., is about 70.

The relative and actual humidities of the air at ordinary temperatures may be determined from the following tables, compiled from those in use by the United States Signal Service if the difference between the temperatures of wet and dry bulb thermometers is known. *Example:* Dry Bulb, 70°; wet, 65°; difference, 5°; under 5° opposite 70° is 77 relative, 6.15 actual.

DEPRESSION OF THE WET BULB.

Temperature.	1°		2°		3°		4°		5°		6°		7°		8°	
	R.	A.	R.	A.	R.	A.	R.	A.	R.	A.	R.	A.	R.	A.	R.	A.
25	88	1.41	76	1.19	63	1.00	52	0.84	40	0.65	28	0.47	17	0.28	4	0.09
26	88	1.48	76	1.30	65	1.09	53	0.88	42	0.71	30	0.52	19	0.34	8	0.15
27	89	1.54	77	1.35	66	1.14	54	0.96	43	0.77	32	0.57	22	0.39	11	0.19
28	89	1.61	78	1.41	67	1.19	56	1.00	45	0.81	34	0.62	24	0.45	14	0.25
29	89	1.67	78	1.48	67	1.30	57	1.09	47	0.88	36	0.68	26	0.49	16	0.31
30	90	1.74	79	1.54	68	1.35	58	1.14	48	0.96	38	0.74	28	0.57	18	0.37
31	90	1.82	79	1.61	69	1.41	59	1.24	49	1.00	40	0.81	30	0.62	21	0.43
32	90	1.89	80	1.74	70	1.48	61	1.30	51	1.09	41	0.88	32	0.68	23	0.49
33	90	1.97	80	1.82	71	1.61	62	1.35	52	1.14	43	0.96	34	0.74	25	0.54
34	90	2.05	81	1.89	72	1.67	63	1.48	53	1.24	44	1.00	35	0.81	27	0.62
35	91	2.13	81	1.97	72	1.74	64	1.54	54	1.30	45	1.09	37	0.88	29	0.68
36	91	2.29	82	2.05	73	1.82	64	1.61	55	1.41	47	1.19	38	0.96	30	0.77
37	91	2.38	82	2.13	74	1.89	65	1.67	56	1.48	48	1.24	40	1.04	32	0.84
38	92	2.47	83	2.21	75	2.05	66	1.82	57	1.54	50	1.35	42	1.14	34	0.92
39	92	2.56	83	2.29	75	2.13	67	1.89	58	1.67	51	1.41	43	1.19	35	1.00
40	92	2.66	84	2.38	76	2.21	68	1.97	59	1.74	52	1.54	44	1.30	37	1.09
41	92	2.76	84	2.47	76	2.29	68	2.05	60	1.82	53	1.61	46	1.41	38	1.14
42	92	2.86	84	2.66	77	2.38	69	2.21	61	1.89	54	1.67	47	1.48	40	1.24
43	92	2.97	85	2.76	77	2.47	70	2.29	62	2.05	55	1.82	48	1.61	41	1.35
44	92	3.08	85	2.86	78	2.56	70	2.38	63	2.13	56	1.89	49	1.67	43	1.48
45	92	3.19	85	2.97	78	2.76	71	2.47	64	2.21	57	1.97	50	1.74	44	1.54
46	93	3.31	85	3.08	79	2.86	72	2.56	65	2.38	58	2.13	51	1.89	45	1.67
47	93	3.43	86	3.19	79	2.97	72	2.76	66	2.47	59	2.21	52	1.97	46	1.74
48	93	3.55	86	3.31	79	3.08	73	2.86	66	2.56	60	2.38	53	2.13	47	1.89
49	93	3.68	86	3.43	80	3.19	73	2.97	67	2.66	60	2.47	54	2.21	48	1.97
50	93	3.81	87	3.55	80	3.31	74	3.08	67	2.86	61	2.56	55	2.29	49	2.05
52	94	4.09	87	3.81	81	3.55	75	3.31	69	3.08	63	2.86	57	2.56	51	2.29
54	94	4.38	88	4.09	82	3.95	76	3.55	70	3.31	64	3.08	59	2.86	53	2.56
56	94	4.70	88	4.54	82	4.23	77	3.95	71	3.68	65	3.31	60	3.08	55	2.86
58	94	5.03	89	4.86	83	4.54	78	4.23	72	3.95	67	3.68	61	3.43	56	3.08
60	94	5.38	89	5.20	84	4.86	78	4.54	73	4.23	68	3.95	63	3.68	58	3.43
62	95	5.76	89	5.57	84	5.20	79	4.86	74	4.54	69	4.38	64	4.09	59	3.81
64	95	6.15	90	5.95	85	5.57	79	5.20	74	5.03	70	4.70	65	4.38	60	4.09
66	95	6.57	90	6.36	85	5.95	80	5.76	75	5.38	71	5.03	66	4.70	61	4.38
68	95	7.25	90	6.79	85	6.36	81	6.15	76	5.76	71	5.38	67	5.20	63	4.86
70	95	7.74	90	7.25	86	7.02	81	6.57	77	6.15	72	5.95	68	5.57	64	5.20
72	95	8.25	91	7.74	86	7.49	82	7.02	77	6.57	73	6.36	69	5.95	65	5.57
74	95	8.80	91	8.25	86	7.99	82	7.49	78	7.25	74	6.79	70	6.36	66	6.15
76	95	9.37	91	8.80	87	8.52	82	7.99	78	7.74	74	7.25	70	6.79	66	6.57
78	96	9.98	91	9.37	87	9.08	83	8.52	79	8.25	75	7.74	71	7.49	67	7.02
80	96	10.62	92	9.98	87	9.67	83	9.08	79	8.80	75	8.52	72	7.99	68	7.49
							82		80	9.37	76	9.08	72	8.52	69	8.25
							84		80	9.98	77	9.67	73	9.08	69	8.80
							86		81	10.62	77	10.29	73	9.67	70	9.37
	9°		10°		11°											
40	30	0.88	22	0.65	15	0.45	88		81	11.29	77	10.95	74	10.62	71	9.98
41	31	0.96	24	0.74	17	0.54	**90**		81	12.38	78	11.64	75	11.29	71	10.62
42	33	1.04	26	0.81	19	0.62	92		82	13.15	78	12.38	75	12.00	72	11.64
43	34	1.14	28	0.92	21	0.71	94		82	13.96	79	13.15	75	12.76	72	12.38
44	36	1.24	29	1.00	23	0.77	96		82	14.81	79	13.96	76	13.55	73	13.15
45	37	1.30	31	1.09	24	0.88	98		83	15.71	79	15.25	76	14.38	73	13.96
46	38	1.41	32	1.19	26	0.96	**100**		83	16.65	80	16.18	77	15.25	74	14.81
47	40	1.54	34	1.30	28	1.04	102		83	17.65	80	17.14	77	16.18	74	15.71
48	41	1.61	35	1.41	29	1.14	104		83	18.69	80	18.16	77	17.65	74	16.65
49	42	1.74	36	1.48	30	1.24	106		84	19.79	81	19.23	78	18.69	75	17.15

DEPRESSION OF THE WET BULB.

Temperature.	9°		10°		11°		12°		13°		14°		15°		16°	
	R.	A.	R.	A.	R.	A.	R.	A.	R.	A.	R.	A.	R.	A.	R.	A.
50	43	1.82	37	1.61	32	1.35	26	1.14	21	0.88	16	0.68	10	0.43	5	0.20
51	45	1.97	39	1.74	33	1.48	28	1.24	22	1.00	17	0.77	12	0.54	7	0.31
52	46	2.05	40	1.82	35	1.61	29	1.35	24	1.09	19	0.88	13	0.62	9	0.41
53	47	2.21	41	1.97	36	1.74	31	1.48	25	1.19	20	0.96	15	0.74	10	0.49
54	48	2.29	42	2.05	37	1.82	32	1.61	27	1.30	22	1.09	17	0.84	12	0.59
55	49	2.47	43	2.21	38	1.97	33	1.74	28	1.48	23	1.19	18	0.92	14	0.71
56	50	2.56	44	2.29	39	2.05	34	1.82	30	1.61	25	1.30	20	1.04	15	0.81
57	50	2.76	45	2.47	40	2.21	36	1.97	31	1.67	26	1.41	21	1.19	17	0.92
58	51	2.86	46	2.56	42	2.38	37	2.05	32	1.82	27	1.54	23	1.30	18	1.04
59	52	2.97	47	2.76	43	2.47	38	2.21	33	1.97	29	1.67	24	1.41	20	1.19
60	53	3.19	48	2.86	44	2.66	39	2.38	34	2.13	30	1.82	25	1.54	21	1.30
61	54	3.31	49	3.08	44	2.76	40	2.47	35	2.21	31	1.97	27	1.67	22	1.41
62	54	3.43	50	3.19	45	2.97	41	2.66	37	2.38	32	2.13	28	1.82	24	1.54
63	55	3.68	51	3.31	46	3.08	42	2.76	38	2.56	33	2.29	29	1.97	25	1.67
64	56	3.81	51	3.55	47	3.19	43	2.97	38	2.66	34	2.38	30	2.13	26	1.82
65	56	3.95	52	3.68	48	3.43	44	3.08	39	2.86	35	2.56	31	2.29	27	1.97
66	57	4.09	53	3.81	49	3.55	45	3.31	40	2.97	36	2.66	32	2.38	29	2.13
67	58	4.38	53	4.09	49	3.68	45	3.43	41	3.19	37	2.86	33	2.56	30	2.29
68	58	4.54	54	4.23	50	3.95	46	3.55	42	3.31	38	3.08	34	2.76	31	2.47
69	59	4.70	55	4.38	51	4.09	47	3.81	43	3.55	39	3.19	35	2.86	32	2.66
70	60	4.86	55	4.54	52	4.23	48	3.95	44	3.68	40	3.43	36	3.08	33	2.76
72	61	5.38	57	5.03	53	4.70	49	4.38	45	4.09	42	3.68	38	3.43	35	3.19
74	62	5.76	58	5.38	54	5.03	50	4.70	47	4.38	43	4.09	40	3.81	36	3.43
76	63	6.15	59	5.95	55	5.57	52	5.20	48	4.86	45	4.54	41	4.09	38	3.81
78	63	6.79	60	6.36	56	5.95	53	5.57	49	5.20	46	4.86	43	4.54	39	4.23
80	64	7.25	61	6.79	57	6.36	54	6.15	51	5.76	47	5.38	44	5.03	41	4.70
82	65	7.74	62	7.49	58	7.02	55	6.57	52	6.15	48	5.95	45	5.57	42	5.20
84	66	8.25	63	7.99	59	7.49	56	7.25	53	6.79	49	6.36	46	5.95	44	5.57
86	67	8.80	63	8.52	60	8.25	57	7.74	54	7.25	51	7.02	48	6.57	45	6.15
88	67	9.37	64	9.08	61	8.80	58	8.25	55	7.99	52	7.49	49	7.02	46	6.57
90	68	10.29	65	9.98	62	9.37	59	9.08	56	8.52	53	7.99	50	7.74	47	7.25
92	69	10.95	65	10.62	62	9.98	59	9.67	56	9.08	54	8.80	51	8.25	48	7.74
94	69	11.64	66	11.29	63	10.95	60	10.29	57	9.98	54	9.37	52	8.80	49	8.52
96	70	12.38	67	12.00	64	11.64	61	10.95	58	10.62	55	9.98	53	9.67	50	9.08
98	70	13.55	67	12.76	64	12.38	61	12.00	59	11.29	56	10.95	53	10.29	51	9.98
100	71	14.38	68	13.55	65	13.15	62	12.76	59	12.00	57	11.64	54	10.95	51	10.62

Temperature.	17°		18°		19°		20°		21°		22°		23°		24°	
	R.	A.	R.	A.	R.	A.	R.	A.	R.	A.	R.	A.	R.	A.	R.	A.
70	29	2.47	26	2.21	22	1.89	19	1.61	16	1.35	12	1.04	9	0.81	6	0.54
71	30	2.66	27	2.38	23	2.05	20	1.82	17	1.48	14	1.19	10	0.92	7	0.68
72	31	2.86	28	2.56	24	2.21	21	1.97	18	1.67	15	1.35	12	1.09	9	0.81
73	32	2.97	29	2.66	25	2.38	22	2.13	19	1.82	16	1.54	13	1.24	10	0.96
74	33	3.19	30	2.86	26	2.56	23	2.29	20	1.97	17	1.67	14	1.41	11	1.09
75	34	3.31	31	3.08	27	2.76	24	2.47	21	2.13	18	1.89	15	1.54	12	1.24
76	35	3.55	31	3.19	28	2.97	25	2.66	22	2.29	19	2.05	16	1.74	14	1.41
77	35	3.81	32	3.43	29	3.08	26	2.86	23	2.47	20	2.21	17	1.89	15	1.61
78	36	3.95	33	3.68	30	3.31	27	2.97	24	2.66	21	2.38	18	2.05	16	1.82
79	37	4.23	34	3.81	31	3.55	28	3.19	25	2.86	22	2.56	19	2.29	17	1.97
80	38	4.38	35	4.09	32	3.68	29	3.43	26	3.08	23	2.76	20	2.47	18	2.13
81	38	4.54	35	4.23	33	3.95	30	3.68	27	3.31	24	2.97	21	2.66	19	2.38
82	39	4.86	36	4.54	33	4.09	31	3.81	28	3.43	25	3.19	22	2.86	20	2.56
83	40	5.03	37	4.70	34	4.38	31	4.09	29	3.68	26	3.31	23	3.08	21	2.76
84	41	5.20	38	4.86	35	4.54	32	4.23	29	3.95	27	3.55	24	3.19	22	2.97
85	41	5.57	38	5.20	36	4.86	33	4.54	30	4.09	28	3.81	25	3.43	22	3.08
86	42	5 76	39	5.38	36	5.03	34	4.70	31	4.38	29	3.95	26	3.68	23	3.31
87	42	5.95	40	5.57	37	5.20	34	4.86	32	4.54	30	4.23	27	3.81	24	3.55
88	43	6.36	40	5.95	38	5.57	35	5.20	32	4.86	30	4.54	27	4.09	25	3.81
89	44	6.57	41	6.15	38	5.76	36	5.38	33	5.03	31	4.70	28	4.38	26	3.95
90	44	6.79	41	6.36	39	6.15	36	5.76	34	5.38	32	5.03	29	4.54	26	4.23
91	45	7.25	42	6.79	39	6.36	37	5.95	35	5.57	33	5.20	30	4.86	27	4.54
92	45	7.49	43	7.02	40	6.57	37	6.15	35	5.76	33	5.38	30	5.03	28	4.70
93	46	7.74	43	7.25	41	7.02	38	6.57	36	6.15	34	5.76	31	5.38	29	5.03
94	46	7.99	44	7.74	41	7.25	39	6.79	36	6.36	34	5.95	31	5.57	29	5.20
95	47	8.25	44	7.99	42	7.49	39	7.02	37	6.57	35	6.36	32	5.95	30	5.57
96	47	8.80	45	8.25	42	7.74	40	7.49	37	7.02	36	6.57	33	6.15	30	5.76
97	48	9.08	45	8.52	43	8.25	40	7.74	38	7.25	36	6.79	33	6.36	31	5.95
98	48	9.37	46	8.80	43	8.52	41	7.99	38	7.49	37	7.25	34	6.79	32	6.36
99	49	9.67	46	9.37	44	8.80	41	8.25	39	7.99	37	7.49	34	7.02	32	6.57
100	49	9.98	47	9.67	44	9.08	42	8.80	39	8.25	37	7.74	35	7.25	33	7.02
102	50	10.95	47	10.29	45	9.98	43	9.37	40	8.80	38	8.52	36	7.99	34	7.49
104	51	11.64	48	11.29	46	10.62	44	10.29	41	9.67	39	9.08	37	8.80	35	8.25

MANAGEMENT OF THE CARDING-ROOM.

This room is arranged under the usual mill plan: an overseer and second hand being required to supervise the help. It has been found advisable in the arrangement of mills to have a different overseer over each department, so that each one can criticise the others' product and keep him up to the mark.

As in other departments of a mill, crowding should not be allowed in any event. The machinery is designed for certain speeds and productions, and no machine bears over production so badly as a card. The clothing is apt to be seriously damaged, and the product affects all the subsequent machinery.

In setting up and starting roving-frames, see that all parts are level and in line, and firmly fixed where they belong; rub the steel rolls lengthwise with whiting and oil, on a piece of card clothing. This will take off all the sharp edges and make them run much better. Oil the shells and all roll bearings, and wipe off all dirty oil. Run some time before putting work into them. Look out for hot bearings; they damage the machine and are very liable to set loose cotton on fire. Each spindle and flyer wants the same attention in starting that it would have if there were but one to be run instead of thousands. If anything is found broken or damaged so that it will not fill its requirements properly, it should not be tinkered, but thoroughly made good without delay. Careful attention to the covering of the top-rolls will detect any uneven places and save trouble later.

Great attention has been given in late years to providing a proper temperature and moisture in the various parts of the mill; not only for the benefit of the cotton processes, but also for the benefit of the help in hot weather. We do not care to specify any particular plan, but there are several very efficient mechanical means on the market for producing additional air and moisture.

CARD CLOTHING.

English Counts.	Points per Square Foot.	American No. of Wire.
60s	43,200	28
70s	50,400	30
80s	57,600	31
90s	64,800	32
100s	72,000	33
110s	79,200	34
120s	86,400	35
130s	93,600	36

SPINNING.

The usual spinning room comprises spinning frames, spoolers, warpers, banding machines and possibly twisters and reels. As in any other department, the main object to be accomplished is large production of a proper product, at low cost. The quality of the product is more or less governed by the roving sent in from the card room. There are many ways, however, in which poor yarn can be made, without allowing any such excuse.

Yarn is used for many purposes, which require varying degrees of twist, evenness and strength. Warp yarn is largely governed in the usefulness of its application, by its liability to break in the loom. Such breakage has been carefully watched, and found to result largely from knots and bunches rather than from weakness. Bunches may be due to bad piecings, or to unclean frames. Knots are inevitable; yet the difficulty can be aggravated by careless tying at the spooler. The ultimate goal of theoretic perfection in spinning, would be the production of yarn that had been continuously spun without a break from unpieced roving. It is possible that conditions of the future will absolutely eliminate piecings, trusting entirely to knots, and the best type of knots, at the spooler, to give the necessary length to warp yarn. The large ring and long traverse system has eliminated the necessity for so many spooler knots, although introducing the necessity for additional power to carry heavier loads on the spindle, and greater traveler wear on the larger rings.

The breakage of ends on spinning frames is a fairly good criterion of the conditions in the spinning room. An end does not break without good reason. Granted, a fair quality of roving, there are plenty of other chances for defects on the way to the spindle. The rolls may not be in good condition, or be improperly spaced; the guide wire may be grooved or improperly placed; the ring may not be concentric with the spindle; the traveller may not be of the proper shape, or weight, and the spindle, itself, may vibrate. Yarn spun from double roving must have its traveller adjusted so that single yarn cannot be spun when one supply of roving is broken, or exhausted. Care must also be taken to prevent a broken end from allowing roving to run in with the adjacent delivery, thus making yarn of double size.

The careful spinner should know what conditions to demand, in the first place, for the yarn to be spun, appreciating the necessary relative position of rolls, guide wire, and ring rail. He should also be posted on draught and twist, and be

capable of securing efficient and intelligent co-operation from the help under him. It is well to keep posted on what is being done in other mills, to arouse a proper stimulation of effort, to prevent being beaten under similar conditions. Tests made on single frames are often of great advantage in determining the possibility of higher speed and therefore greater production. Many overseers, of course, accept conditions as they find them, and struggle along with antiquated machinery. The importance of keeping up with modern improvements has nowhere been so well illustrated, as in the replies received from inquiry cards sent out to the various cotton mills in the country, to determine their frame speeds and productions. The newer mills, with the latest frames, were invariably making the best records, although not employing any radical change in principle.

In view of the fact that certain information furnished in the past through circular or letter, by our Mr. Welch, is often asked for, we take pleasure in reprinting several compendiums on spinning, which are all of value to that special department.

The following is an almost verbatim copy of a circular issued by George Draper & Sons in 1884. The fact that it is still applicable, is a strong argument for its original truth. Mr. Welch had been employed in spinning rooms for thirty years before arriving at the conclusions herein given.

All hands employed should have their duties assigned with definiteness, and so work to the best advantage. These duties include the care, with the lighting and ventilating of the rooms; general oversight of the operation of the frames, and banding, cleaning and oiling them; care of shafting and fire apparatus, collecting and weighing waste, handling the yarn until delivered to the slasher and weaver; and various other points which will suggest themselves to overseers in the proper operation of the mill.

Before starting up new frames, they should be very carefully leveled both ways. The parts should be thoroughly cleaned before putting together, or if necessary, should be taken apart to clean and oil freshly. For the first two or three weeks, oil everything six times as often as you do old frames; wipe off all black oil and apply plenty of new. A frame ought to be scoured a few weeks after starting and all bearings wiped out. Where ring rails are left rough underneath I like the idea of shellacking them, especially on filling frames, to prevent the lint from adhering. Steel rolls sometimes give trouble from fibres catching and causing them to wind up. Polishing

with whiting and oil, or sawdust and oil, using a piece of card clothing lengthwise the flutes and afterward rubbing with clean waste, will remedy this difficulty."

Further details on this matter from later dissertation:

"Make a paste of whiting and animal oil that, when thoroughly mixed, will have the consistency of hasty pudding, then procure some pieces of card clothing about six inches square; remove the front steel roll from the frame and put it on stands made for the purpose; fill the flutes by hand with the mixture, and also fill the card clothing full of it; then have the roll scoured thoroughly by rubbing the roll lengthwise with the flutes, going over every inch at least 500 times, keeping the card well filled with the paste all the time; go over again with sawdust just the same, and clean with waste. When the roll has been scratched in any way, a fine file should be carefully used; this should be attended to before the scouring."

"Look out for undue friction in lifting rod bushings and cylinder bearings. The first set of new bands is generally spoiled by the new cylinder, and ought to come off within a month; the second set can be put on looser. Travellers should be kept in good condition, using one or two numbers lighter at the start than afterwards; the first set will soon wear out, but they will last longer and longer with each renewal. Avoid oiling the rings. Every new bobbin should be tested, seeing that they fit the spindle and run true. Rings and guide wires must be accurately adjusted. Top rolls, if dented or jammed in shipping, are unfit for use.

After frames are started in good shape it has been my practice to scour three times a year, when all the steel rolls are taken out, laid on proper supports and thoroughly cleaned, wiped and lubricated, cleaning the flutes by brushing lengthwise with a stiff brush, remedying any roughness in the same way as described for new rolls. When the rolls are put back in place, a small piece of tallow is crowded in between neck of roll and stand. Back and middle steel rolls are oiled twice a week through a tunnel made for the purpose put through a hole drilled in the cap-bar. This makes it certain that the oil goes where it was intended to go. The front steel rolls are oiled twice a day with a Thompson can. I have never allowed spinners to use a hook or anything of metal to clean front rolls when wound up; this prohibition has kept the front rolls of my frames in first-rate condition, and they are without a scratch after running twenty-eight years, during which time they have never been stoned or re-fluted.

The back and middle top rolls are oiled twice a week on their middle bearings, and once a week on their end bearings. (I use double boss rolls.) This oiling is done with a can, but

for oiling the front top rolls, I use a special contrivance of my own, which I will describe as a conical tin tube, which may be put on the finger of an operative like a glove finger; into the small end of this tube is crowded a piece of sponge saturated with oil. The oiler takes a can in one hand, and with this tube on one of the fingers of the other hand, he passes rapidly along the frames, putting a drop or two of oil on the sponge, and pressing it for a moment on each bearing of the roll. This gives all the oil necessary for complete lubrication, and leaves no surplus to run off or get on the leather of the roll. This oiling is done twice a day on my warp and four times a day on my filling frames, because they run at greater speed than the warp. I consider that while all other parts of a frame may be oiled with mineral oil, the top rolls should be oiled with sperm. I have never tried any other kind for this purpose, without finding it a serious disadvantage. Front top rolls are cleaned twice a day with a sponge dipped in a mixture of equal parts of alcohol and water, other top rolls are cleaned weekly. When frames are scoured I examine top rolls and twist in the hand to see if the covering is loose; and I put them in so as not to run against the end of the lap. Work cannot be made to run well unless the top rolls are in good condition and well cleaned and oiled, and the middle roll should be in about as good condition as the front one. I never attempted to see how few new-covered rolls I could get along with, believing that to save in that respect would cost more in some other way.

As to saddles, I have tried wood, iron, bronze and raw hide, and my preference is for cast iron. The proper weighting of the top roll is an important point; care should be taken to keep the levers about horizontal, or they will be dropping down and relieving the rolls of the necessary amount of pressure, by the wire ring striking the creel-board. This is a matter often neglected by careless overseers, and bad work is sure to follow. Stirrups should not be allowed to get out of place and rub on either side of the steel rolls.

The guide wires should not be used after they become creased, and they should be kept carefully set so that the point where the thread bears will be directly over the center of the spindle.

The rings must be adjusted so each spindle will stand exactly in the centre of its ring. Whenever the frames are scoured, the rings ought to be thoroughly wiped out and examined. They should all be readjusted once in two or three years, or oftener. I have had the double adjustable rings in use nearly five years, and so far no new ones have been needed for repairs. Every few years I have had a trough made of sufficient size to hold a ring-rail, and give every rail a

bath of a hot solution of potash or sal-soda, letting it remain half an hour. A rinsing in hot water leaves the rail perfectly clean. No trouble from stained yarn will be experienced with such care and cleaning. It is important to keep lifting rods clean, true and well oiled; they should not be allowed to run as sometimes happens, in bushings which are loose.

Frames should be carefully leveled up every few years.

I have used low double creels and found them to work to good advantage.

In my early experience I adopted the common custom of changing travelers throughout once in five or six weeks: but for the last twenty years I have abandoned this system and have taught spinners to detect and remove worn-out travellers. This course secures an evener draft with one third less travellers. Cups holding one or two hundred travelers are at the centre of each creel. The traveler cleaners need some attention to see that they are set so as to keep dirt and lint from the travelers. The spinners are taught to feel of the traveler every time they piece up an end, by putting the forefinger on the traveler inside the ring and the thumb on the outside; then moving the finger to the left will detect any roughness or sharpness on the right hand side of the traveller, which is where the wear chiefly comes.

The bobbins are carefully fitted to the spindles. They should be examined and tried on a standard spindle once a year at least, and ill-fitting ones made right by reaming or thrown away. I allow no yarn to be cut off from a bobbin by any hand but mine to make sure that the bobbins are not marred in that way. The speed of the traverse motion is regulated so as to get as much yarn as possible on a bobbin by laying the coils close together on the barrel of the bobbin. I prefer bands made of roving instead of yarn, as they have fewer strands and less stretch. I examine the bands myself at least once in two or three weeks by feeling of each while doffing or cleaning is going on, and cutting off such as are too slack or too tight. I am entirely satisfied that an average of two pounds band pull is more than enough, provided the bands are looked after as described."

The following additions may be made from more recent compilations.

Top rolls require careful attention. The custom of using a wornout front roll as a back or middle roll, is wrong. A fluted roll will make coarser yarn from the same roving, as the corrugations pass more yarn through in the same time. A damaged roll should be knifed by chopping a piece out of the covering, cloth and all, so that when re-covered, it will have new cloth as well as new leather. The cloth should be of suf-

ficient thickness to form a good cushion, and the leather should not be put on too tight. The middle roll should always be in as good condition as the front roll. There is more poor spinning made by the use of damaged top rolls than in any other manner except poor bands.

Roving guides should be kept in constant movement, and never allowed to stop when the heart motion changes. This heart motion often gets worn or loose, causing the rod to have a back lash. This is damaging to the rolls, as it allows greater wear at certain portions of the traverse.

Lifting rods should work easily, and if Shaw & Flinn cleaners are applied, there will be no danger of sticking.

Spindles should be banded and run sometime before adjusting the rings. Rings should always be set with the spindles running. It is of great importance to have the spindles absolutely central in their rings, and as the traverse may not be absolutely vertical, it is well to try the spindles at the bottom of the traverse as well as at the top. When a set of full bobbins of yarn are on, this can be easily watched by breaking the ends down and changing the position of the ring rails. A spindle that is central at one position of the traverse and badly out at another, should be leveled by papering up between the spindle base and the rail. Guide wires should deliver exactly over the top of spindle, and care should be taken to adjust them properly. As new bands will stretch after use, it is well to apply them tighter than they are intended to run. A new band should pull perhaps three to four pounds; after running, it should pull about two to three pounds. Bands are very treacherous, as their tension depends on freshness, moisture and amount of oil absorbed. Bands are put on with the frame both running and stopped. A band of course can be applied better with the frame stopped, but there is a question as to the loss of time in stopping the frame. With bands marked on a Weeks' banding machine, the band boy is less liable to make mistakes in tension.

New spindles need frequent oiling at the start, as for some unknown reason spindles will throw out and waste oil more in the first week than ever afterwards. Our spindles are usually oiled every two or four weeks. There is no question but that they will average to run twice as long as this, or more; but the trouble is that the boys who oil them are liable to be careless, and either skip spindles or oil some of them in such haste that the bases are not properly filled. The usual hand pours as much oil on the floor as gets in the spindle. Much of this oil runs down the base, gets on the bands, and is generally objectionable. It is evident that careful, competent help, is needed here, although oil is so cheap as to appear to warrant little

economy. We believe in the use of light gravity spindle oil about 33 to 38. If an extremely light oil is used, it may actually leak through the pores of the cast iron bases. Where thick oil is used, it consumes great amounts of power, and is also more liable to gum and stick. The price of oil for a spinning room is not to be considered an instant, as the entire cost of the oil used may be saved in a few weeks at the coal pile, by proper selection.

Extra top rolls should be kept in boxes made for the purpose to hold them perpendicularly, and the lid should be cushioned on the under side in such manner as to hold the rolls from damage when in transit from the roll coverer.

Bobbins should fit the sleeve of the whorl rather than the cup on our spindles, although a fit in both places is desirable. Filling bobbins often swell or warp from the moisture in the loom room, and require frequent reaming or replacement. In order to keep bobbins of uniform size, iron samples should be made to order by. These should be stamped with the name of the mill.

Care must be taken in adjusting the saddles, levers and weights, so there will be no undue friction or loss of leverage. The Speakman lever screw is the best means we know of for keeping the weights in proper action.

It is well to have the second hand examine all the spindles in a room at intervals, to see whether any are vibrating excessively. Frequently when a spindle vibrates, it is because the bearing has worn loose. This can be easily remedied on any of our late types, by adjusting the fit of the bolster. Where the bolster is badly worn out of round, it is well to supply a new one. If careful adjustment or replacement of bolster will not help the case, the spindle blade is probably bent and a new one must be used. The second hand should also look after the banding, to see that the position of the snout or hook on the spindle base is not such as to rub and wear the band. Spindle bases should be kept clean, else the flying lint may get sucked in between the whorl and base to such extent as to actually consume power in driving the spindle. It is a frequent custom in England to clean out spindle bases. We are of the opinion that this is entirely unnecessary with our spindles, providing a good, light oil is used. There will be a certain amount of grit always, but it will settle in the bottom of the base and do no damage in our opinion. Should anyone wish to know the best method of cleaning, the one we should recommend would be taking out the bolsters and blowing them out with a steam jet or soaking them in naptha. The bases can be cleaned with a suction pump and swab, or by means of a steam jet, provided they are taken out of the frames.

Extracts from letter written by William Welch to an overseer of spinning, February, 1899:

"The strength of a warp is the weakest thread in it; if there is one weak thread, that thread will run through the whole warp, and possibly stop a loom 500 times, before the warp is woven out; and if there are ten weak threads, or one hundred weak threads, it will multiply the trouble in proportion and this will lessen the production of the loom, besides making imperfect cloth.

It would be well for you to commence at one end of the room and take a frame every day, or even one a week, and go through it, commencing on your roving guides and seeing that they are in perfect order. In going around your room I saw several that were loose and tipped over, so that there was not an inch between threads. This, as you know, will make double yarn, and when it gets into the loom and is woven, will damage the cloth at least half a cent per yard; so it is important that these roving guides should be kept in proper order. If any of them are weak they want to be discarded and new brass trumpets put in their places.

On your back and middle top rolls your bearings were all dry, and I do not believe a drop of oil has got through those wicks in two years, and if any oil has got onto the bearings it must have got there by being put on the side of the saddle. It must have taken a great deal of power to drive the frame with so many dry bearings and such a heavy weight on the rolls.

Many of your levers were down. Where the lever is down and the wire rests on the board, it makes cut yarn. Cut yarn is weak yarn and will break, if not on the spooler and warper, it will when it comes to be slashed and gets into the loom, and break badly.

Many of your steel rolls were extremely dirty. The laps between the spaces had not been removed since they were scoured. Waste should never be allowed to accumulate until it gets into a lap. Spinners should be taught to take a piece of waste once in two weeks, at least, and rub them off underneath, and by rubbing the roll off with dry waste you will not have one roving wound up on the middle roller where you now have five.

If the back and middle steel rolls get sticky, the roving will run around the middle roll, and this is a great annoyance. It not only lifts the roll up and makes cut yarn on the other end, but it is very difficult to get it off the roll, and in many mills they cut it off, and this roughs up the roll and makes the matter worse. You should instruct your girls to wipe these

off once in two weeks. I know of mills where it is done once a week.

The ends of the top roll require but very little oil, in fact a drop on your finger drawn across them once a week is sufficient.

I need not tell you that thread guides should be set directly over the spindle; I need not tell you that your spindles should be set in the center of the ring; you must know these things ought to be so. Your rings should be looked over, and those that are wavy and uneven should be turned over if they have not been. A poor ring will destroy enough travellers every six months to pay for a new ring, to say nothing of the extra amount of waste that you will make, and poor yarn besides.

You have only been oiling your spindles once in four weeks. You should oil them every two weeks, and *they should be oiled. You* should *know* that *they are oiled*, and to *know it you* have got to examine them once in a while unknown to the man that oils them. A dry spindle will make poor yarn. A spindle that is vibrating badly will not only make poor yarn, but it will destroy the bearing, because of its pounding. It is a small matter to adjust these spindles. Roving bands of 120 to the pound on your frame are heavy enough and light enough. A band should not be twisted too hard; if you twist it too hard it will have to be put on very tight, or else it will soon get loose and make slack twisted yarn.

You know we found a great many of the bands running above the whorl. Now that part of the spindle is smaller than the whorl, hence it will give you more twist in your yarn, and this extra twist, which you do not need, will cause your filling to kink.

When you see black oil coming out of any bearing, whether it is a steel roll, a spindle, or a box on the end of the frame, it is evidence that there is something wearing. Quite a number of your pulleys are shaking badly. Where a pulley is shaking badly it will shake all the bolts loose in time, it will make flat places on the journals, and the bad results will multiply and cause everything about the frame to wear out sooner and it certainly will not improve the running of the work.

Help should be taught. When a hand comes into your room and hangs up his coat and hat, the next thing he should be taught is to roll up his sleeves. Many a boy has lost his arm by having his sleeve down.

I noticed under your frames a great many bobbins on the floor, some with yarn on and some empty. I also noticed on top of your frames both full and empty bobbins all covered with lint. A boy should be taught when he drops a bobbin to

pick it up; bobbins should be gathered up off the frames every doff and put in their proper places.

I found some parts of your frames very dirty between the spindles. If you allow the lint and waste to accumulate between the spindles, the bands will load up and grow larger, and you will not get the proper twist in your yarn. If you watch the boy that makes the bands, and see that he keeps a certain number of strands of roving up all the time, your bands must be uniform in size even if they are not uniform in twist.

The busier you keep your section men and assistants, the better and more contented they will be."

Before purchasing new frames, the following points should be considered:

In buying new spinning frames, important points to look after are the spindles, rings and separators. The difference between the products of the various builders is not what it used to be so far as the frame itself is concerned, and good workmanship can now be obtained from any American builder.

So far as spindles are concerned, there are but three on the market to-day. The Draper, or improved 49 D Rabbeth, is the result of years of experiment by some of the best spindle experts in the world, and we recommend it without hesitation. The Whitin is a very popular, well designed spindle, and the McMullan (Saco-Pettee) has hosts of friends. Either of the three will run at any required speed and do good work. The only questions between them are on the points of wear, power and general convenience.

As to separators, they must be of some wide-bladed form, to meet present requirements. We know of none but the Rhoades-Chandler that meets every requirement. The Chandler idea has been extensively copied, but a copy is usually inferior to the original.

As to rings, there is no question. The double flanged ring in plate holder with traveller cleaner, is almost universally used. A few still prefer common rings, but their eccentricity is an expensive luxury. We recommend the rings we sell, because we know what they are from the steel bar to the finished ring. No one is more ready to adopt improvements than we are, and we have been improving our processes of ring making for nearly thirty years.

Weight is of great importance in a frame; proper setting up and levelling also. Cut gearing runs more smoothly than cast gears, and should be insisted on.

Our expert, Mr. Welch, has given us the following requirements that he would wish for in a mill of his own selection:

"Spinning frames are usually made from 160 to 224 spindles.

I prefer frames 39 inches wide, or as near that as possible. I prefer single boss rolls for all kinds of yarn, though many good spinners may differ with me.

Would have the flutes on steel rolls 1-8 inch longer than the top rolls when they are covered, so as to prevent the top rolls from getting off the flutes, and thus prevent trouble.

The clearer cloths should be hung on wires, and never glued on the boards.

Underclearers should be made of maple or whitewood, and covered with white slasher cloth; they should be hung on weights and not on springs.

Should want iron or steel roving guide rods with brass trumpets with about 1-4 inch slot so that they can be moved slightly either way.

Should want Speakman lever screws, Dixon's latest patent lock saddles, and also a good roving guide regulator. Should want some of the latest thread board lifters, and these should have hinges near together to prevent the boards from sagging or getting out of shape.

Creels should be made so as to give as much room for roving as possible. Creel steps or "pots" should be glass, and sunk slightly in the wood.

Should want 5 1-2 inches or 6 inches distance from bite of front rolls to thread guides on warp and at least 2 1-2 inches from top of bobbin to thread-guide, though 3 inches would be better for 2 inch rings and long traverse. On filling frames I would have this distance 1 1-2 inches.

The right angle thread guide with a little kink arrester screwed into the door that the thread guide enters, I consider the best thing for yarns from 28s upward. This kink arrester should be screwed into the board, so as to hang directly over the inside of the flange of the ring.

The driving pulleys on frames should be at least 12 inches in diameter, and the tight pulley should be about 1-4 inch larger in diameter than the loose pulley. I would have a 2 inch face, and where frames are belted overhead, would have a flange on the outside of the tight pulley 7-8 inch wide. This will prevent the belt from running in between the frame and pulley.

Would want 6 lifting rods on a side for a frame of 160 spindles and about that proportion on other frames, rods to rest on truck rolls, with the Shaw & Flinn lifting-rod cleaners applied to each.

If frames are to be warp, I would have ring rails bored for 2 inch ring, for 2 3-4 inch gauge frame, and if a 3 inch guage is used would have them bored to take a 2 1-4 inch diameter ring. This of course, would require at least a 3 1-4 inch wide ring rail.

Should want double rings with plate holders, traveller cleaner being made a part of same, made so as to be self-cleaning.

Would have compound builder on frames, so that either warp or filling can be spun without much trouble in changing.

For change gears would want one gear each side of the one used, both for weft and twist. Top roll ends should project slightly above the cap bars, so that the waste, etc., can be removed without the use of a picker. It is next to impossible to keep ends of rolls clean when they are sunk down in the cap bars. Places should be left in the cap bars, so that the steel rolls can be oiled conveniently. I would have hole in base rail 1-16 inch larger than the stem of base. This will allow a little room to adjust spindles, so that it will not be necessary to depend on the ring holder altogether.

One very important point is the bobbin. Silver birch makes a first-class spinning bobbin, both for filling and warp. For a 1 3-4 inch to 2-inch ring on yarns 28s and downward. the barrel of the bobbin ought to be 7-8 inch diameter. It should have a steel ring or equivalent at the bottom, to prevent it from splitting. The upper bearing should never fit tight on the spindle, and should be at least 3-4 inch long. The bobbin should fit the sleeve bearing from 1-2 inch to 5-8 inch, at the same time entering the cup about an eighth of an inch. Bobbins made in this way never will rise up on the spindle. Where it is practicable the long traverse bobbin can be "bored back" at the top, leaving the walls with sufficient strength for usage. This will make the bobbin light at the top. Bobbins ought to be oiled and shellacked; the length of life of the bobbin will more than offset the difference in cost. Bobbins that are not true should be discarded altogether.

The writer knows of a case where spools made as follows were used for 21 years. The heads were made of white wood, barrels made of same wood excavated and bushed with hard wood bushings; the heads were scant half-inch thick, sloping off the usual way 4-inch diameter, 5-inch traverse.

This makes a light, strong spool. The heads should be shellacked, never painted. Nothing but clear stock should be used. The following dimensions make a good spool for yarns from 35s up to 50s, 4 1-2 inch traverse. 7-16 inch thickness for head tapered off to edge, 3 3-4 inches diameter of head, 1 1-2 inches barrel, same to be white wood as above. Bushings should

be at least 3-4 inches long to project slightly on the outside, so as to prevent spool from rubbing against side of creel.

For yarns 28s and under, I would use a 5 1-2 inch to 6 inch traverse and from 4 inch to 4 1-2 inch diameter spool head, made of the same material as the above, but of course, have the heads large, half inch thick, tapered the usual way.

Spools and bobbins should always be shellacked, so that if poor stock is used it can be easily detected.

Filling bobbins should be made according to the diameter of ring used. The top bearing should fit loose and should be at least 3-4 inch long, and an inch would be still better. They should fit the sleeve at least half an inch, same as the warp bobbins, entering the cup about an eighth of an inch.

Where filling bobbins are liable to be wet, they should be soaked in pure linseed oil and receive two coats of pure alcohol cut shellac.

Bobbins should be reamed so that they will be quite loose on the top bearing, this being simply a steadying and not an adhesive bearing."

It is of course understood that with the continual changes wrought by invention and experiment, it is impossible to give advice that will apply to future conditions. The reader must depend on his own good judgment to modify the above suggestions in accordance with the development which is constantly going on.

POWER TESTING ON FRAME SPINDLES.

Extracts From Paper Presented to the New England Cotton Manufacturer's Association at their meeting in Philadelphia, October 27, 1897, by George Otis Draper, Secretary of the Draper Company:

ELEMENTS OF POWER CONSUMPTION.

The spindle of commerce, as known at the present day, consists in a highly perfected structure evolved by a continuous improvement representing about forty years of experimenting. When reduced to lowest terms it must be considered simply as an upright revolving shaft.

The modifications in detail, however, have made this particular class of shaft peculiar, in allowing it to run steadily at a higher speed than any other mechanical structure known, which is used in large numbers.

The elements of power consumption are of course similar whatever the type of spindle. Their proportion, however, varies so widely with different forms, that it is necessary to determine the absolute influence of each separately.

The consumption of power by a revolving body is a problem involving the laws of friction, as affected by pressure, centrifugal force and speed. The elements producing friction in this case are as follows:

In the first place, the spindle shaft itself is necessarily somewhat imperfect. Measured by an infinitesimal scale it would be found to be crooked, out of round, eccentric and of round surface. Its bearings are of course similarly defective.

The load carried by it, while performing work, consisting of the bobbin and yarn, is unsymmetrical in outline and of rough surface, producing air resistance, and is uneven in distribution of weight, causing the centre of gravity to be more or less on one side of the axis. This develops a centrifugal force, increasing the bearing friction, also increasing the air resistance, by the gyration which it may cause.

The pull of the traveler caused by air resistance, and the friction of the traveler itself on the ring, also add considerable work, acting as a brake or retarding force.

The pull of the band adds to the lateral friction in the bearings, and the oil, or lubricant used, varies the co-efficient of friction.

These different elements of power vary with the quality of work performed by the spindle, its speed of rotation, and its design or construction. The work required is of course independent of the spindle itself, as it is regulated by the amount

of weight to be carried, and the amount of drag on the traveler. The speed should not only increase the power in proportion to the amount of work accomplished, but according to physical laws, should increase certain power elements by the square of the velocity, namely, those governed by the eccentricity of the moving parts.

Here, however, we encounter one of the perplexing features of the modern type of spindle, as its use of yielding bearings allows the speed to be increased without apparently increasing the vibration.

The principal element of power consumption in a spindle is usually the amount of lateral friction due to the tension of the band. In present practice, this force pressing the spindle against its bearing, is equal to a direct pull, varying from a quarter of a pound to, perhaps, eight pounds.

In earlier years, when heavier spindles were used, and also larger bands, the tension sometimes ran up to sixteen pounds. The average band pull on a frame in the usual mill is probably between two and four pounds, although one pound would be ample for ordinary conditions if constantly maintained. As bands are greatly affected by difference in temperature and moisture, the usual tension has to be high enough to allow variation.

The other important factor of power in the naked spindle is the bearing friction due to the lateral pressure from the centrifugal force developed by the uneven mass of the revolving structure. The air resistance of the smooth metal parts must be trifling.

The factor next in importance is usually the drag effect of the traveler pull, especially when spinning coarse yarns. This consumes a large amount of power, and varies with the size of the yarn being spun, the amount of twist, and the speed of the spindle. The amount of drag is adjusted by the weight of the traveler, and is therefore independent of any modification in the spindle itself.

Another element is the weight or load carried by the spindle. This varies the vertical friction on the vertical support, which, however, is not important. The increase of power noted as weight is added is mainly due to the centrifugal force developed by the increasing unevenness of the load which multiplies the lateral bearing friction. The air resistance is also an important factor, as the yarn surface is rough and unevenly distributed.

The band pull appears to be an easy problem, but in reality is very difficult of solution. Bands are made of pliable yarn or roving which is capable of great stretch, and constantly affected by changes in humidity. Not only are they affected by moisture

in the air, but they also absorb oil thrown out by the spindles, and are liable to considerable contraction merely for resting between periods of work. When a frame is started up in the morning it can easily consume over 10 per cent. more power than when the bands have stretched by a few hours' running. A slight rain storm can also put the power up over 10 per cent. during the day. The boys who tie on the bands are rarely held accountable for getting them too tight and the incentive is always in the wrong direction, as they are responsible for any troubles arising from too slack bands. The spinning overseer also naturally has little concern in the amount of power used in the engine room when it does not show in his own cost of production. The prevention of a little slack yarn is often accomplished at the cost of tons of coal and years of wear. The general evils of the banding system can probably only be cured by an entirely new method of application or new construction or substance in the bands themselves.

Coming to the spindle itself, it is first essential to have the shaft perfectly straight, as any crook will multiply the bearing friction and the air resistance. It should also be proportioned so that it will not be bent by any handling or strain that it is liable to in use. Spindles have been used in large numbers that consumed power in excess simply because of the intermittent bending they were subject to, on account of their too slight structure. The friction of the shaft in its bearing will of course vary with the diameter, yet experience shows it is safer to use a large shaft that will not bend rather than try to reduce power by approaching the danger line of bending strain with a small bearing section.

The spindle most universally known to-day allows a small average bearing section by use of a tapering pintle, together with a maximum strength near the bending point.

A loose fit, as before stated, will save power, although sometimes at the expense of good running. The usual practice in modern spindles which have an adjustable fit, is to send them out closely fitted, as they are sure to run steadier in this manner, more surely meeting the approval of the purchaser. They will therefore use less power later by wearing themselves a more liberal fit.

Spindles after a year's running show considerable reduction in power, other things being equal. To offset this improvement is another element of a dangerous character, consisting in the dirt or sediment made chiefly by the iron ground out from the bearings. Part of it is also due to the sediment contained in the oil, which varies in importance with the grade of oil used. Spindles that are not properly oiled, and run partly dry, grind out a great deal of iron at times. This dirt, whatever its nature,

has a bad effect, as it naturally thickens the lubricant, thereby consuming power. It can be prevented by liberal use of oil at the start, when the wear is most serious, thereby flooding it out. The only other method is to remove the spindle and bearings, and clean the base with a suction pump or swab. Cleaning spindles is a frequent custom in England, but has never been taken up in this country to any marked extent. It probably is not necessary in mills which use clear light oil and plenty of it.

FIGURES OF POWER TESTS SELECTED FROM PUBLISHED DATA.

Name of Spindle.	Spindles to H. P.	No of Yarn	Speed.
Common	80	12	5050
Sawyer	108	12	5200
Common	108	30	5000
Sawyer	169	30	5000
Old Rabbeth	178	29	5104
Common	103	28	5460
Pearl	138	28	5488
Common	101	33	5900
Sawyer	132	30	6000
Old Rabbeth	141	28	6059
Pearl	141	28	6059
New Rabbeth	150	30	6000
Modified Sawyer	117	28	6418
New Rabbeth	140	28	6713
Sawyer	106	30	7000
New Rabbeth	120	30	7000
Modified Sawyer	91	28	7573
Common	92	28	7539
New Rabbeth	120	28	7439
Modified Sawyer	81	28	8113
Common	82	28	8124
New Rabbeth	95	30	8000
Modified Sawyer	71	28	8934
Common	71	28	8948
New Rabbeth	82	28	9100
McMullan	86	30	9100
Eureka	92	35	9500
Whitin	112	40	9491

PRACTICAL METHODS OF POWER TESTING.

Power tests are necessary for various purposes. In the first place it is often necessary to find out how much power is required for a spinning-room without regard to the spindle itself. It is sometimes possible to determine this factor by indicating the engine when running the spinning department alone, or by attaching a power scale to the main driving shaft of the room. It is, of course, impossible to get an accurate result by merely testing one frame, as the frames themselves vary considerably, owing to variation in tension of their driving belts, and the friction in many of their bearings. Another reason for power testing is to determine whether power can be saved by making certain changes in the spindles or the methods of using them. There is great practical advantage in such tests, as we have always found when testing frames that it was possible to save a considerable fraction of power by simply putting the frame in what we consider proper condition for testing.

The simple methods of reaching these conditions could be easily enforced in any spinning room at slight expense, with great saving. Very few mills pay sufficient attention to their bands. Very few use a proper oil. Many never take advantage of the adjusting fit which may be present in their spindles, thereby allowing them to correct bad running and loosen tight bearings. As before stated, hardly any mill pays any attention to the removal of dirt from the spindle bearings. Then there are the evils of too heavy roll weighting, frames out of level, rings out of center, accumulation of dirt, etc.

The following plan of making a power test is suggested from the experience of the writer as having been used on recent important experiments with highly satisfactory results.

If a test is made on a frame in a mill, first find the power consumed as it stands, by the following method:

It is understood, of course, that the person making the test shall thoroughly understand the use of dynamometer or power scale. Unless this knowledge has been acquired, the test will have no value.

First, take the power consumed by the frame spinning just before doffing. Then take the power directly after doffing. Take all readings at the center of the traverse. This gives the two extremes of spinning and by adding together and dividing by two, the average power of the frame will be given as accurately as possible without involving a large amount of figuring. It is more satisfactory than taking the power when the spinning first starts, and then waiting for the bobbins to fill before determining the average power taken, as the necessary length of time may introduce great changes in atmosphere, thereby vitiating the test. After the empty bob-

bins have had about fifteen minutes' delivery of yarn on them, break the ends all down, keeping the rolls running, and carefully determine the power. Then throw the rolls out of gear and run the spindles with the small bobbins on them. The difference between these two power records will show the actual power consumed by the rolls and traverse motion.

Then take these small bobbins off, replacing with the full bobbins, running the spindles without the rolls as before. By adding this record together with the record of the small bobbins without rolls and dividing by two, the power taken by the average weight of the yarn load and spindle is known. Then take the bobbins off and run the spindles bare. Subtracting this record from the former one will show the actual power taken by the average yarn load with its bobbin. After having repeated this series several times to get the proper average, weigh the band pull carefully and then cut the bands entirely off.

Now the actual power of the cylinder can be taken. With these records the power is sufficiently divided for practical purposes. By adding the power of the spindle, the weight and the rolls together, and subtracting from the power taken by the average of spinning, the result will give the average power taken by the traveler pull.

Having these records it is possible to find out how much power can be saved by getting the frame in better condition. First, see that it is accurately levelled and then carefully clean and oil every running part. Then go over the spindles and make sure they are properly set to the rings at all parts of the traverse. Go over the guide wires and see that they are all centered, removing any wires that are badly worn.

Then take the spindles apart and clean the bearings thoroughly in naphtha or with a steam jet, removing the old oil from the base with a suction pump and swab. Then if the spindles have adjustable bearings, see that the fit is made uniform. Then apply new bands, running them long enough to take out the first stretch. Next carefully weigh the band pull and by cutting tight and loose bands get the average down to as near two pounds as possible. When this tension is reached properly it must be maintained as constantly as possible, even if the band pull has to be taken as often as twice a day, as otherwise the comparisons in the tests will be largely a comparison of bands. In figuring the test results make proper allowance for any fraction of tension above or below the standard.

Now run the spindles bare until it is evident that they have reached a uniform consumption of power. From this on tests can be made without waiting for the intermediate filling

of bobbins by simply putting the large bobbins on, piecing up, running about fifteen minutes and then doffing. By counting the number of layers of yarn applied meanwhile, it is easy before the next test to wind off this amount, thereby having the conditions uniform for all tests. Of course if the bobbins get snarled or damaged spin fresh ones.

If it is found during testing that certain elements which should be constant, vary excessively, continue the records until the error is eliminated.

Tests should be made at a uniform time of day, if it is possible, as the bands contract over night, affecting the power consumed in the first few hours.

On rainy or damp days, if tests are taken, it will be necessary to make allowance for the change in band pull and other conditions, as the power will necessarily be greater. Moisture affects bands in other ways than the mere contraction. A band may have small tension and yet consume power by not being pliable. If making comparative tests, it is safer not to run on such days. The general stickiness affects the general conditions in many annoying ways.

If the tests include comparison on different spindles, it is essential either to have them taken from new lots that have not run or to have two lots that have had equal wear. If comparing adjustable taper bearing spindles with the straight bearing spindle, the looseness of fit in the taper bearing must be made as uniform as possible with the looseness allowed the other.

POWER CONSUMPTION UNDER VARIOUS CONDITIONS.

The ratio of power consumption to band tension is found to be uniform enough so that a scale may be figured sufficiently accurate for ordinary practice on the usual spindles. Where larger size spindles, such as are used for coarse yarn or twisting, are used, a different scale would be necessary.

An important factor in band power is the size of the band. A large band produces more air resistance, and consumes more power at the same tension. The scale given, therefore, is figured for two sizes of ordinary bands. It might be said, however, that the large bands have little excuse for use on the usual spindle.

Revolutions.	Bands about 120 to the pound H. P. per spindle.	Bands about 80 to the pound H. P. per spindle.
At 1000 each pound of band tension adds	.00017	.00027
At 2000 " " " " "	.00035	.00050
At 3000 " " " " "	.00055	.00065
At 4000 " " " " "	.00075	.00090
At 5000 " " " " "	.00095	.00115
At 6000 " " " " "	.00120	.00140
At 7000 " " " " "	.00145	.00170
At 8000 " " " " "	.00170	.00200
At 9000 " " " " "	.00200	.00230
At 10000 " " " " "	.00230	.00265
At 11000 " " " " "	.00260	.00300
At 12000 " " " " "	.00295	.00340

These figures are derived from actual tests supplemented by figuring for speeds not actually tried. The pressure of the band itself increases the power at a practically uniform ratio, but the air resistance increases at an ascending ratio. The figures given have nothing to do with the power taken by the spindle independent of its band tension. For instance, suppose a frame with a known band tension of three pounds shows 80 spindles to the horse power, on average spinning conditions, at 8000 revolutions, small bands being used, to figure the power with a two-pound tension, divide one by 80, giving the number .0125, which represents the actual horse power taken by each spindle; then subtract .0017, the power added by a pound tension on one spindle at this speed; the remainder will be .0108; this divided into one gives 92 and a fraction, which is the number of spindles to the horse power which would be obtained at a pound lower tension.

It is also evident that these figures will show the power which would be consumed by the spindle, supposing some method of driving were invented which would eliminate the entire tension. For instance, taking the first figure of 80 spindles to the horse power at a three-pound tension, figuring .0125 horse power for each spindle, the horse power added by the three-pound tension is three times .0017, or .0051; subtracting this from .0125 leaves .0074 horse power per spindle, or, dividing into one, equals 135 (and a fraction) spindles to the horse power. Looking at it in another way, the band tension of three pounds in this instance consumes $\frac{51}{125}$ of the total power required by the whole frame.

POWER CONSUMPTION OF VARIOUS ELEMENTS.

Absolute division of power units under certain definite conditions. Some of the figuring involves estimates within certain known limits. Speed, 8,500; band tension, 2 lbs.; bands weigh 120 to lb.; bobbin weight 500 grains; average weight of yarn weighs 800 grains; No. of yarn, 26-28; 7 inch traverse; 1¾ ring.

		Indicated H. P. per Spindle.	
1.	Lateral friction and air resistance of frame cylinders,	.00032	
2.	Air resistance of bands,	.00100	
3.	Friction of bare spindles due to band tension of 2 lbs.,	.00270	
4.	Friction of bare spindles due to centrifugal force of uneven mass and air resistance,	.00264	
A.	Total power of cylinder bands, and bare spindles,		.00666
5.	Vertical friction due to weight of spindle and average load,	.00000*	
6.	Friction from centrifugal force of uneven mass in bobbin,	.00030	
7.	Friction from centrifugal force of uneven mass in average yarn load,	.00090	
8.	Air resistance of yarn surface on average load,	.00080	
B.	Total power of average yarn load,		.00200
9.	Pull of traveller from friction and air resistance,	.00273	
C.	Total power of average traveler pull,		.00273
10.	Friction of rolls, traverse motion and gearing,	.00100	
D.	Total power of rolls, traverse and gears,		.00100
	Average total power of frame,	.01239	.01239

Number of spindles per horse power, 80+

.0239)10000
9912

88

*The increase of weight within the usual limits does not affect the power taken by certain modern spindles. This is proved by a test with iron cylinders absolutely true and smooth, so far as possible. The increased power taken by the bobbin of yarn is due to its rough surface and eccentricity of weight. Theoretically any weight must increase the vertical friction, but in practice the weight probably aids in steadying the spindle and thus cancels its expected requirement.

The results noted in lines A, B, C and D are sufficient for ordinary practice.

Taking the result of this test at 80 spindles to the H. P. or

.01239 H. P. per spindle, consider what the evil effect of certain common faults might add. The following figures are not estimates but were actually derived from tests in mills.

*Good running condition	= .01239	H. P. per spindle.
A cramped cylinder has often added an extra	.00030	" " " "
An increase of band pull to three pounds will add	.00185	" " " "
Cheap low gravity oil will certainly add	.00200	" " " "
Dirt and sediment in the spindles have shown an extra	.00300	" " " "
Poor bobbins could easily add	.00030	" " " "
Too heavy travelers or rings out of center might add	.00050	" " " "
Rolls poorly oiled, tightly fitted or too heavily weighted have added	.00200	" " " "

.02234)1.0000 | 44–|– spindles
8936 | to H. P.

1064

*Equals 80 spindles to horse power in this case.

The reduction from a possible 80 which is by no means a maximum to 44 seems unreasonable, yet we have known of a showing of 50 spindles with conditions similar so far as speed and yarn are concerned to the first test quoted. This comparison assumes the same type of spindle in both cases. If an inferior style is used there is yet more chance for waste of power.

The question of the ratio of power to speed is not so simple a problem as that of the ratio of band tension. It has always been assumed that a spindle increased its power in accordance to the speed, by a certain definite formula, the plotted curves being always constant; that is, if the power increased at a certain proportion from 5,000 to 6,000, the same formula used would show usually a larger increase from 10,000 to 11,000. As some of the elements of power are supposed to increase at a uniform ratio, and others at a constantly increasing ratio, the addition of both would produce a rate of increase somewhat higher than a uniform scale.

Actual tests, however, do not bear out such a theory, as a curve plotted from actual experience begins to flatten at a certain speed, which probably varies with the class of spindle tested.

RATIO OF POWER TO SPEED

Figured for a modern spindle from actual test under following conditions: Band tension 2 lbs. on average: bands weighing 120 to lb.; bobbin weighs 500 grains; average weight of yarn load weighs 800 grains; No. of yarn spun 26-28; 7-inch traverse $1\frac{3}{4}$ ring.

Total Power	Revs.	Ind. H. P. per Spindle. 7000	8000	9000	10000	11000
Of cylinder and bare spindles,		.0047	.0060	.0070	.0078	.0085
Of average yarn load, with bobbin,		.0009	.0016	.0021	.00255	.0029
Of average traveler pull,		.0010	.0021	.0029	.00325	.0035
Of rolls, gears and traverse motion,		.00065	.0009	.0011	.00125	.0013
Of frame under average spinning conditions,		.00725	.0106	.0131	.01485	.0162
No. of spindles per H. P.		137+	94+	76+	67+	61+

It must be distinctly understood that this scale of variation is not necessarily adaptable to any other spindle or any different conditions. Of course it may aid in estimating.

Any mill interested in economy of power should give attention to the following points, many of which have already been noted:

The spinning frame itself should be driven through a long belt if possible, which can have less tension, and where short belts are necessary, the frame pulley should be large for the same purpose. The belt tension is not included in the usual frame power test, but its variation is often equivalent to over twenty per cent. of the power taken by the frame itself.

The use of large rings and long traverse must affect the question of power, although there is usually more than enough economy in other directions to balance the extra power required.

The speed, of course, governs everything, as velocity increases power at a ratio which is usually higher than a mere percentage. We have known of several instances, however, where mill men considered our spindles defective on noting the increased power required by new frames, losing sight of the fact that they were both increasing the speed and the size of the bobbin. Coarse yarn will inevitably take more power to produce than fine numbers. Heavy spindles of the same style will always take more power than light ones, although the power comes rather from the increase of bearing section and centrifugal force, than the mere added weight.

By using a little care the regular small spindle can be used for quite heavy work with a great saving in power, especially as the heavier type naturally requires a higher band tension also.

PRODUCTION TABLES.

The details of the figures given for production and speed are necessarily different from those appearing in our former books, and they do not coincide with those given by any other authority. In order to prepare them we asked for information from every mill having frame spindles in this country, and while a statistical table must necessarily conform to some rule of progression, the results indicated can be paralleled by actual facts.

These tables are not made up from average results, but rather represent a high average, though not a maximum. When our table was published in 1896, the large ring fad was at its height. In our present table our recommendations in this line are more moderate. On the other hand, the traverse now recommended is slightly longer on certain numbers. Most tables figure out revolutions of the front roll in decimals, from an assumed spindle speed. Our tables give roll speed, spindle speed and hank production in even figures for greater convenience of application. The warp twist is figured from the ordinary warp twist table, up to and including No. 35. This standard is made by multiplying the square root of the number of the yarn by 475. The use of longer stapled cotton for numbers above 35 has led to a reduction in twist for finer yarns. In our tables we use a twist from No's. 40 to 80, figured by multiplying the square root of the number of the yarn by 450. From 36s to 39s, inclusive, the twist is simply graduated between the two standards. From 80 to 110 the twist is figured by multiplying the square root of the number of the yarn by 4.25.

It is, of course, impossible to meet all the various conditions of twist in a table of this nature, as yarn is used for so many purposes. We have tried to make it conform to the practice of the majority of the mills in this respect.

The production in hanks is necessarily figured from the delivery of the front roll, making proper allowance for doffing, and the contraction of the yarn due to the twist. Of course more time must be allowed for doffing with coarse yarn. The revolutions of the spindle must be sufficient to not only put in the necessary twist per inch, but also to wind the yarn on the bobbin.

In our table of filling yarn the twist is computed from a varying standard as follows:

Up to, and including No. 25, the mule filling twist of 3.25 times the square root is used, as returns from the mills seem to

Production Table of Ring Warp Yarn.
Front Roll 1 Inch in Diameter.

No. of Yarn.	Size of Spindle.	Gauge of frame.	Diameter of ring.	Length of traverse.	Twist per inch.	Revolutions of front roll per minute.	Revolutions of spindle per minute.	Hanks per spindle per day of 10 hours.	Pounds per spindle per week of 58 hours.	Pounds per spindle per week of 60 hours.	Pounds per spindle per week of 66 hours.
4	Draper No. 4.	3 inches,	2¼	7 or more	9.50	204	6200	10.50	15.22	15.75	17.32
5					10 62	200	6800	10.40	12.06	12.48	13.72
6					11.64	196	7300	10.30	9.95	10.30	11.33
7					12.57	192	7700	10.20	8.45	8.74	9.61
8					13.44	188	8100	10.10	7.32	7.57	8.33
9					14.25	184	8400	10.00	6.44	6.66	7.33
10			2⅛		15.02	180	8600	9.80	5.68	5.88	6.46
11					15.75	176	8800	9.60	5.06	5.23	5.76
12					16.45	172	9000	9.40	4.54	4.70	5.17
13					17.13	168	9000	9.20	4.10	4.24	4.67
14					17.77	164	9000	9.00	3.72	3.85	4.24
15					18.40	160	9300	8.80	3.40	3.52	3.86
16					19.	156	9400	8.60	3.11	3.22	3.54
17					19.58	152	9400	8.40	2.86	2.96	3.26
18					20.15	148	9400	8.20	2.64	2.73	3.00
19					20.71	144	9400	8.00	2.44	2.52	2.77
20			2		21.24	140	9400	7.80	2.26	2.34	2.57
21					21.77	138	9400	7.70	2.12	2.20	2.42
22					22.28	136	9500	7.60	2.00	2.07	2.28
23					22.78	134	9500	7.50	1.89	1.95	2.15
24					23.27	132	9600	7.40	1.78	1.85	2.03
25					23.75	130	9600	7.30	1.69	1.75	1.92
26					24.22	128	9700	7.20	1.60	1.66	1.82
27					24.68	126	9700	7.10	1.52	1.57	1.73
28					25.13	124	9700	7.00	1.45	1.50	1.65
29					25.58	122	9800	6.90	1.38	1.42	1.57
30			1¾		26.02	120	9800	6.80	1.31	1.36	1.49
31					26.45	120	9900	6.80	1.27	1.31	1.44
32					26.87	118	10000	6.70	1.21	1.25	1.38
33					27.29	118	10100	6.70	1.17	1.21	1.34
34					27.70	116	10200	6.60	1.12	1.16	1.28
35					28.10	116	10300	6.60	1.09	1.13	1.24
36					28.17	114	10200	6.50	1.04	1.08	1.19
37					28.24	114	10100	6.50	1.01	1.05	1.15
38					28.31	112	10000	6.40	.97	1.01	1.11
39					28.38	112	10000	6.40	.95	.98	1.08
40	Draper No. 2.	2¾ inches,	1⅞	6½	28.46	110	10000	6.30	.91	.94	1.03
41					28.81	110	10000	6.30	.89	.92	1.01
42					29.16	108	10000	6.20	.85	.88	.97
43					29.50	108	10000	6.20	.83	.86	.95
44					29.65	106	10000	6.10	.80	.83	.91
45					30.19	106	10000	6.10	.78	.81	.89
46					30.51	104	10000	6.	.75	.78	.86
47					30.85	104	10000	6.	.74	.76	.84
48					31.18	102	10000	5.90	.71	.73	.81
49					31.50	102	10000	5.90	.69	.72	.79
50			1½		31.81	100	10000	5.80	.67	.69	.76
55					33.37	96	10000	5.60	.59	.61	.67
60					34.86	92	10000	5.40	.52	.54	.59
65					36.28	88	10000	5.20	.46	.48	.52
70					37.65	84	10000	5.	.41	.42	.47
75					38.97	80	9800	4.80	.37	.38	.42
80					39.08	78	9600	4.70	.34	.35	.38
85					39.18	76	9400	4.60	.31	.32	.35
90					40.32	74	9400	4.50	.29	.30	.33
95					41.22	72	9400	4.35	.26	.27	.30
100			1⅝	5 to 5½	42.50	70	9400	4.20	.24	.25	.27

Comparative Production Table of Ring Warp Yarn.

No. of Yarn.	Size of spindle.	Gauge of frame.	Diameter of ring.	Length of traverse.	Twist per inch.	Revolutions of front roll per minute.	Revolutions of spindle per minute.	Hanks per spindle per day of 10 hours.	Pounds per spindle per week of 58 hours.	Pounds per spindle per week of 60 hours.	Pounds per spindle per week of 66 hours.
6	Draper No. 4	3	2¼ 1⅞	7 7	11.64	196 180	7300 6800	10.30	9.95	10.30	11.33 10.10
10		3	2⅛ 1⅞	7 7	15.02	180 178	8600 8500	9.80	5.68	5.88	6.46 6.68
12		3	2⅛ 1⅞	7 6	16.45	172 185	9000 8700	9.40	4.54	4.70	5.17 5.40
13		3	2⅛ 2	7 7	17.13	168 160	9000 8500	9.20	4.10	4.24	4.67 4.48
14		3	2⅛ 1½	7 6¼	17.77	164 169	9000 8100	9.00	3.72	3.85	4.24 4.66
18		2¾	2 1⅞	7 6	20.15	148 150	9400 8800	8.20	2.64	2.73	3.00 3.37
20		2¾	2 1¾	7 7	21.24	140 140	9400 9400	7.80	2.26	2.34	2.57 2.49
22		2¾	2 1¾	7 6	22.28	136 136	9500 9500	7.60	2.00	2.07 2.10	2.28
25		2¾	1¾ 1⅝	6½ 7	23.75	130 130	9600 9500	7.30	1.69 1.69	1.75	1.92
26		2¾	1¾ 1⅝	6½ 6	24.22	128 136	9700 10000	7.20	1.60	1.66	1.82 1.80
28		2¾	1¾ 1½	6½ 5½	25.13	124 122	9700 9750	7.00	1.45 1.47	1.50	1.65
30		2¾	1¾ 1¾ 1½	6½ 6½ 5½	26.02	120 120 122	9800 9750 10000	6.80	1.31 1.34	1.36	1.49 1.48
32		2¾	1⅝ 1¾ 1⅝	6½ 6 6½	26.87	118 115 118	10000 9500 9600	6.70	1.21	1.25 1.30	1.38 1.35
34		2¾	1⅝ 1⅝	6½ 6⅛	27.70	116 120	10200 9500	6.60	1.12	1.16 1.20	1.28
38	Draper No. 2	2¾	1⅝ 1⅝	6½ 6½	28.31	112 112	10000 9700	6.40	.97	1.01 1.00	1.11
40		2¾	1⅝ 1⅝	6½ 6¼	28.46	110 115	10000 10000	6.30	.91 .95	.94	1.03
42		2¾	1½ 1⅝	6 6	29.16	108 100	10000 9200	6.20	.85 .81	.88	.97
50		2¾	1½ 1⅝	6 6	31.81	100 100	10000 10000	5.80	.67 .67	.69	.76
60		2¾	1½ 1⅝	6 6	34.86	92 92	10000 10000	5.40	.52 .57	.54	.59
70		2¾	1⅜ 1⅝	5½ 6	37.65	84 83	10000 9700	5.	.41	.42 .46	.47
80		2¾	1⅜ 1½	5½ 5½	39.08	78 78	9600 9700	4.70	.34	.35 .36	.38
90		2¾	1⅜ 1⅜	5½ 5½	40.32	74 68	9400 9400	4.50	.29 .27	.30	.33
100		2¾	1⅜ 1⅜	5 5½	42.50	70 68	9400 9400	4.20	.24 .24	.25	.27

Production Table of Ring Filling Yarn.
Front Roll 1 Inch in Diameter.

No. of Yarn.	Size of Spindle.	Gauge of frame.	Diameter of ring.	Length of traverse.	Twist per inch.	Revolutions of front roll per minute.	Revolutions of spindle per minute.	Hanks per spindle per day of 10 hours.	Pounds per spindle per week of 58 hours.	Pounds per spindle per week of 60 hours.	Pounds per spindle per week of 66 hours.
4	Draper No. 2, for all Numbers.	2¾ for all Numbers.	1½ to 1⅝.	7 inches.	6.50	240	5000	10.00	14.40	14.88	16.37
5					7.27	230	5400	10.00	11.50	11.95	13.15
6					7.96	220	5600	9.85	9.53	9.86	10.84
7					8.60	214	5800	9.85	8.13	8.40	9.24
8					9.19	208	6000	9.75	7.07	7.31	8.04
9					9.75	202	6200	9.65	6.24	6.46	7.10
10					10.28	196	6400	9.60	5.56	5.76	6.33
11					10.78	190	6500	9.50	5.00	5.18	5.70
12					11.26	184	6600	9.40	4.54	4.70	5.17
13					11.72	180	6700	9.35	4.15	4.29	4.72
14					12.16	176	6800	9.25	3.82	3.95	4.35
15					12.59	172	6900	9.15	3.53	3.65	4.02
16					13.	168	7000	9.05	3.28	3.39	3.73
17					13.40	166	7100	9.00	3.07	3.17	3.48
18					13.79	162	7200	8.80	2.84	2.93	3.22
19					14.17	158	7200	8.70	2.64	2.74	3.02
20					14.53	156	7300	8.60	2.49	2.58	2.83
21					14.89	154	7300	8.50	2.34	2.42	2.67
22					15.24	152	7400	8.40	2.21	2.29	2.52
23					15.59	150	7400	8.30	2.09	2.16	2.38
24					15.92	148	7600	8.20	1.98	2.05	2.25
25					16.25	146	7600	8.10	1.87	1.94	2.13
26					17.84	144	8000	7.95	1.77	1.83	2.01
27					18.19	142	8200	7.85	1.68	1.74	1.91
28					18.52	140	8200	7.75	1.60	1.66	1.83
29					18.84	138	8300	7.60	1.52	1.57	1.73
30					19.17	136	8300	7.55	1.45	1.51	1.66
31					20.88	134	8800	7.45	1.39	1.44	1.58
32					21.21	132	8800	7.35	1.33	1.38	1.52
33					21.54	130	8900	7.25	1.27	1.31	1.44
34					21.87	128	8900	7.20	1.22	1.27	1.39
35					22.19	126	8900	7.10	1.17	1.21	1.33
36					22.50	124	8900	7.00	1.12	1.16	1.28
37					22.81	122	8800	6.90	1.08	1.11	1.23
38					23.12	120	8800	6.80	1.03	1.07	1.18
39					23.42	118	8800	6.70	.99	1.03	1.13
40					23.72	116	8800	6.65	.96	1.00	1.10
41					24.01	114	8700	6.55	.92	.96	1.06
42					24.30	112	8700	6.40	.88	.91	1.00
43					24.59	110	8600	6.30	.84	.87	.96
44					24.87	108	8600	6.20	.81	.84	.93
45					25.16	106	8500	6.10	.78	.81	.89
46					25.43	104	8500	6.	.75	.78	.86
47					25.71	104	8500	6.	.74	.76	.84
48					25.98	102	8400	5.90	.71	.73	.81
49					26.25	102	8300	5.90	.69	.72	.79
50					26.52	100	8200	5.80	.67	.69	.76
55					27.00	96	8200	5.50	.58	.60	.66
60					27.00	92	8000	5.30	.51	.53	.58
65					27.00	88	7700	5.10	.45	.47	.52
70					27.19	84	7400	4.90	.40	.42	.47
75					28.15	82	7400	4.80	.37	.38	.42
80					29.07	80	7400	4.60	.33	.34	.37
85					29.96	78	7400	4.60	.31	.32	.35
90					31.00	76	7400	4.40	.28	.29	.32
95					31.68	74	7400	4.40	.26	.27	.30
100					32.50	72	7400	4.30	.24	.25	.28

	1¼	5½	6½	
	1⅜	6		
	5			

COMPARATIVE PRODUCTION TABLE OF RING FILLING YARN.

No. of Yarn.	Size of spindle.	Gauge of frame.	Diameter of ring.	Length of traverse.	Twist per inch.	Revolutions of front roll per minute.	Revolutions of spindle per minute.	Hanks per spindle per day of 10 hours.	Pounds per spindle per week of 58 hours.	Pounds per spindle per week of 60 hours.	Pounds per spindle per week of 66 hours.
6		2¾	1⅝	7	7.96	220	5600	9.85	9.53	9.86	10.84
			1½	6¼		240	5600		10.20		
8		2¾	1⅝	7	9.19	208	6000	9.75	7.07	7.31	8.04
			1⅝	6½		204	5600			7.30	
10		2¾	1⅝	7	10.28	196	6400	9.60	5.56	5.76	6.33
			1½	7		190	6250		5.		
12		2¾	1⅝	7	11.26	184	6600	9.40	4.54	4.70	5.17
			1½	7		184	6650		4.60		
			1⅝	7		185	6800				4.75
14		2¾	1⅝	7	12.16	176	6800	9.25	3.82	3.95	4.35
			1½	7		160	6400		3.75		
			1 7/16	6		170					4.07
16		2¾	1½	6½	.13	168	7000	9.05	3.28	3.39	3.73
			1¼	6½		166	6700				4.08
18		2¾	1½	6½	13.79	162	7200	8.80	2.84	2.93	3.22
			1⅜	5½			7600			2.90	
20		2¾	1¼	6½	14.53	156	7300	8.60	2.49	2.58	2.83
			1 7/16	6		154	7200				3.10
22		2¾	1½	6½	15.24	152	7400	8.40	2.21	2.29	2.52
			1 5/16	5½		172	8330		2.90		
24		2¾	1½	6½	15.92	148	7600	8.20	1.98	2.05	2.25
			1¾	7		156	7800				2.48
25		2¾	1½	6	16.25	146	7600	8.10	1.87	1.94	2.13
			1 7/16	6		148	7650			2.10	
	No. 2.					156			1.91		
26		2¾	1⅜	6	17.84	144	8000	7.95	1.77	1.83	2.01
			1 7/16	6		140	7600				2.00
			1⅜	6¼		142	9100			1.80	
34		2¾	1⅜	6	21.87	128	8900	7.20	1.22	1.27	1.39
			1¼	6½		128	9000			1.28	
36		2¾	1⅜	5½	22.50	124	8900	7.00	1.12	1.16	1.28
			1¼	5½		124	8800		1.12		
			1¼	6¼		132	9500			1.23	
38		2¾	1⅜	5½	23.12	120	8800	6.80	1.03	1.07	1.18
			1⅜	6		122	8800				1.35
40		2¾	1⅜	5½	23.72	116	8800	6.65	.96	1.00	1.10
			1⅜	6		110	8700		.94		
			1⅜	5½		118	9500				1.10
42		2¾	1¼	5½	24.30	112	8700	6.40	.88	.91	1.00
			1¼	5½		114	9000		.80		
			1¼	6		129	9000		1.07		
44		2¾	1¼	5½	24.87	108	8600	6.20	.81	.84	.93
			1¼	5½		103	8200		.81		
48		2¾	1¼	5½	25.98	102	8400	5.90	.71	.73	.81
			1⅛	5½		103	8200		.74		
50		2¾	1¼	5½	26.52	100	8200	5.80	.67	.69	.76
			1⅜	5½			8400		.74		
60		2¾	1¼	5	27.	92	8000	5.30	.51	.53	.58
			1⅜	6½		88	7300				
70		2¾	1¼	5	27.19	84	7400	4.90	.40	.42	.47
						72	7200		.34		
			1⅜	5¾		98	8000		.49		

show that the coarser numbers can be spun with this amount of slackness, to advantage. From No. 25 to No. 30, inclusive, the twist is figured at 3.50 times the square root, and above No. 30 at 3.75, which is the mule warp twist.

It has been thought useless to give theoretical spindle speeds, as the usual facilities for counting speed are not adapted to fine results. No variation is figured at less than one hundred turns per minute. This seems near enough, as the speed varies, more or less, from frame to frame and from hour to hour.

The comparative tables show actual figures from mills as compared with the computation of estimated progression. Figures from the standard table are first placed opposite the number of yarn and figures then follow, giving actual results on the same yarn. We show one or two instances where the mill results are greatly in excess of our own table. We could have given many more, if necessary, to prove our own recommendations moderate. It is not wise to rely absolutely on the spindle speeds that are quoted from the mills, as they are often estimated, or figured without allowing for slip of bands.

CONSTANTS.

While certain twist constants are universally used in figuring textile operations, the application of this principle, is not, so far as we know, carried out for convenience in other relations. Mr. George A. Vaughan, superintendent of the Putnam Mfg. Co., has sent us the following data, which he uses in his own mill. Of course, by following the same principle, one could work out other constants, for application in other mills where the conditions may be different.

PRODUCTION CONSTANTS.

CONSTANTS.	SPEEDERS.
.467 for $1\frac{1}{4}''$ roll. .421 for $1\frac{1}{8}''$ roll.	Rule—Divide .467 (slubbers and intermediate), or .421 (fine speeders and jacks), by the hank number and multiply the quotient by the revolutions per minute of the front roll. The result is the production at 100 per cent. in lbs. per spindle per week of 60 hours.

SPINNING FRAMES.

.374 for 1″ roll.

Rule—Divide .374 by number of yarn and multiply the quotient by R. P. M. of the front roll. The result is the production at 100 per cent. in lbs. per spindle per week of 60 hours. For week of 58 hours the constant would be .362 and for 66 hours, .411.

MULES.

7.143 for 60″ stretch.
7.619 for 64″ stretch.
7.976 for 67″ stretch.

Rule—Divide the constant by the number of yarn, and multiply the quotient by the number of stretches per minute. The result is the production at 100 per cent in lbs. per spindle per week of 60 hours.

LOOMS.

.100

Multiply 100 by the number of picks per minute and divide by the picks per inch. Result is the production at 100 per cent. in yards per week of 60 hours.

The spinning constants given above allow no time for doffing, etc. The following table gives a system of progressional constants in which allowance for loss of time has been made in conformity with the results as shown in our production table. It will be found useful for conditions where it is desirable to know what production should be obtained from frames having roll speeds which differ from those we have assumed.

For instance, taking the constant .328 for No. 28 warp yarn on 58 hours run we find production at the roll speed given of 124 turns as follows:

28)	.328	.0117
	28	124
	48	468
	28	234
	200	117
	196	1.4508 *Answer.*

Our warp production table gives 1.45 or the same result. Now to find the comparative production on No. 28 warp yarn at 120 revolutions of the front roll, multiply .0117 by 120 = 1.40.

For No. 29 to No. 34 yarn the same constant would be used; that is, wherever there is a blank, use the constant given above it.

Table of Constants.

Number of yarn.	Revolutions of front roll recommended by our warp table.	Constant for warp for 58 hours production in pounds.	Constant for warp for 60 hours production in pounds.	Constant for warp for 66 hours production in pounds.	Revolutions of front roll recommended by our filling table.	Constant for filling for 58 hours production in pounds.	Constant for filling for 60 hours production in pounds.	Constant for filling for 66 hours production in pounds.
4	204	.298	.308	.338	240	.240	.248	.273
5	200	.302	.312	.343	236	.250	.258	.284
6	196	.305	.315	.346	220	.260	.268	.295
7	192	308	.318	.350	214	.266	.275	.302
8	188	.311	.321	.353	208	.272	.281	.309
9	184	.315	.326	.357	202	.278	.287	.316
10	180				196	.284	.293	.323
11	176	.316	.326	.359	190	.290	.300	.330
12	172				184	.296	.306	.337
13	168	.317	.328	.360	180	.300	.310	.341
14	164	.318	.328	.361	176	.304	.314	.346
15	160				172	.308	.318	.350
16	156	.319	.329	.362	168	.312	.322	.355
17	152	.320	.330	.363	166	.314	.324	.357
18	148	.321	.331	.364	162	.316	.326	.359
19	144	.322	.333	.365	158	.318	.328	.361
20	140				156	.320	.330	.363
21	138	.323	.334	.367	154			
22	136	.324	.335	.368	152			
23	134				150			
24	132				148			
25	130	.325	.336	.369	146			
26	128				144			
27	126				142			
28	124	.328	.339	.373	140			
29	122				138			
30	120				136			
31	120				134	.321	.331	.364
32	118				132	.322	.333	.365
33	118				130	.323	.334	.367
34	116				128	.324	.335	.368
35	116	.329	.340	.374	126	.325	.336	.369
36	114				124	.326	.337	.370
37	114				122	.327	.338	.371
38	112				120	.328	.339	.373
39	112				118	.329	.340	.374
40	110	.330	.341	.375	116	.330	.341	.375
41	110				114			
42	108	.331	.342	.376	112	.331	.342	.376
43	108				110			
44	106	.332	.343	.377	108	.332	.343	.377
45	106				106			
46	104	.333	.334	.378	104	.333	.344	.378
47	104				104			
48	102	.334	.345	.379	102	.334	.345	.379
49	102				102			
50	100	.335	.346	.380	100	.335	.346	.380
55	96	.337	.349	.383	96			
60	92	.339	.350	.385	92			
65	88	.341	.352	.387	88			
70	84	.343	.354	.390	84			
75	80				82			
80	78				80			
85	76				78			
90	74				76			
95	72				74			
100	70				72			

SPINNING FRAME DIMENSIONS.

American frames are built in regular widths of 36, 39 and 42 inches. The length varies slightly in different makes of frame, so that these figures must not be relied on as absolute for all builds. They are merely intended to give a fair idea for approximate figuring.

NUMBER OF SPINDLES.	2½ IN. GAUGE.		2⅝ IN. GAUGE.		2¾ IN. GAUGE.	
	FT.	IN.	FT.	IN.	FT.	IN.
112	13	10	14	5	14	12
128	15	6	16	2	16	10
144	17	2	17	11	18	8
160	18	10	19	8	20	6
176	20	6	21	5	22	4
192	22	2	23	2	24	2
208	23	10	24	11	26	
224	25	6	26	8	27	10
240	27	2	28	5	29	8
256	28	10	30	2	31	6
272	30	6	31	11	33	4
288	32	2	33	8	35	2
304	33	10	35	5	37	
320	35	6	37	2	38	10
336	37	2	38	11	40	8

NUMBER OF SPINDLES.	3 IN. GAUGE.		3¼ IN. GAUGE.		3½ IN. GAUGE.	
	FT.	IN.	FT.	IN.	FT.	IN.
120	17	2	18	5	19	8
132	18	8	20	½	21	5
144	20	2	21	8	23	2
156	21	8	23	3½	24	11
168	23	2	24	11	26	8
180	24	8	26	6½	28	5
192	26	2	28	2	30	2
204	27	8	29	9½	31	11
216	29	2	31	5	33	8
228	30	8	33	½	35	5
240	32	2	34	8	37	2
252	33	8	36	3½	38	11
264	35	2	37	11	40	8
276	36	8	39	6½	42	5

The above lengths of frames over all are figured with tight and loose pulleys of 2½ inch face. If 3 inch face pulleys are figured, add 1 inch to the above lengths.

BREAKING WEIGHT OF AMERICAN WARP YARNS.

This table given below was made up in July, 1886, after testing samples from over 225 representative mills. We know of no other table so complete or satisfactory.

Breaking weight of American Warp Yarns, per skein. Weight given in pounds and tenths.

Number.	Breaking Weight.	Number.	Breaking Weight.	Number.	Breaking Weight.	Number.	Breaking Weight.	Number.	Breaking Weight.
		20	88.3	**40**	44.6	**60**	31.7	**80**	24.6
1		21	83.8	41	43.8	61	31.3	81	24.3
2		22	79.7	42	43.0	62	30.8	82	24.0
3	530.0	23	75.9	43	42.2	63	30.4	83	23.7
4	410.0	24	72.4	44	41.4	64	30.0	84	23.4
5	330.0	25	69.2	45	40.7	65	29.6	85	23.2
6	275.0	26	66.3	46	40.0	66	29.2	86	22.8
7	237.6	27	63.6	47	39.3	67	28.8	87	22.6
8	209.0	28	61.3	48	38.6	68	28.5	88	22.4
9	186.5	29	59.2	49	37.9	69	28.2	89	22.2
10	168.7	**30**	57.3	**50**	37.3	**70**	27.8	**90**	22.0
11	154.1	31	55.6	51	36.6	71	27.4	91	21.7
12	142.0	32	54.0	52	36.1	72	27.1	92	21.5
13	131.5	33	52.6	53	35.5	73	26.8	93	21.3
14	122.8	34	51.2	54	34.9	74	26.5	94	21.2
15	115.1	35	50.0	55	34.4	75	26.2	95	21.0
16	108.4	36	48.7	56	33.8	76	25.8	96	20.7
17	102.5	37	47.6	57	33.4	77	25.5	97	20.5
18	97.3	38	46.5	58	32.8	78	25.3	98	20.4
19	92.6	39	45.5	59	32.3	79	24.9	99	20.2
								100	20.0

The table on the next page is prepared from figures collected by Mr. Louis Simpson, through friends in England. The only former printed statistics that we know of are the table of Hyde printed in 1867, and the table of Lancaster, printed in 1892. The Lancaster table is evidently based on Hyde's figures, and both are so far below present standards as to be of little use.

Warp yarn is spun on both Mules and Frames in England, Mules being in far larger proportion. We found the variation between the two so slight as affecting the strength of the yarn as not to warrant division. We also found the variation between Egyptian and Best American cotton too slight for sub-division. The Egyptian is slightly ahead.

BREAKING WEIGHT OF ENGLISH WARP YARN GIVEN IN POUNDS.

Number of Yarn.	Ordinary Cotton.			Long Stapled. Egyptian or American.		
	Com.	Fair.	Super.	Com.	Fair.	Super.
12	135	155	185	.....	.....	.....
16	90	100	112	.....	.....	.....
20	75	85	98	.....	.....	.....
26	60	68	78	80	90	100
30	50	55	62	70	80	90
32	45	50	58	65	75	85
36	40	46	53	52	60	68
40	36	40	44	50	55	60
50	.....	.....	.....	40	45	50
60	.....	.....	.....	30	33	37
70	.....	.....	.....	26	28	31
80	.....	.....	.....	20	22	25

WEIGHT OF TEN TRAVELERS IN GRAINS.

Number.	Weight Grains.	Number.	Weight Grains.
23-0	1	8	21
22-0	1¼	9	23
21-0	1½	10	25
20-0	1¾	11	27
19-0	2	12	29
18-0	2¼	13	31
17-0	2½	14	33
16-0	2¾	15	35
15-0	3	16	37
14-0	3¼	17	39
13-0	3½	18	41
12-0	3¾	19	43
11-0	4	20	45
10-0	4½	21	47
9-0	5	22	49
8-0	5½	23	51
7-0	6	24	53
6-0	6½	25	55
5-0	7	26	58
4-0	7½	27	61
3-0	8	28	64
2-0	8½	29	67
1-0	9	30	70
1	10	31	75
2	11	32	80
3	12	33	85
4	13	34	90
5	15	35	95
6	17	36	100
7	19	37	105

RULES FOR SPINNERS.

To find the draught of a spinning frame:—

Write down the number of teeth in all the driving-wheels, and multiply them together. Then write down the number of teeth in all the wheels that are driven, and multiply them together in like manner. If there is any difference in the diameter of the rollers, multiply the least, or driver's product, by the diameter of the back roller; and the largest product, or that of the driven wheels, by the diameter of the front roller. Divide the product of the driven wheels by that of the drivers, and the quotient will be the draught of the machine.

To change the draught-gear on a spinning-frame when changing to a different number of yarn and the draught and roving have both to be altered:—

Multiply the number of yarn being spun, by the hank roving desired, and that product by the number of teeth in the change pinion being used; divide the product thus obtained by the number of yarn desired, multiplied by the hank roving being used. The quotient will show the change pinion required.

To change the draught gear when changing from one number of yarn to another without changing the roving:—

Multiply the number of teeth in the change pinion in use by the number of yarn spun. This product divided by the number of yarn desired will give the change pinion required.

To change the twist-gear when changing to a different number of yarn:—

Square the number of teeth in the present gear, and multiply by the number of yarn being spun. Divide this product by the number of the yarn desired; the square root of the quotient will show the proper number of teeth for the new gear.

To find what per cent. yarn contracts in twisting:—

Divide the number of the yarn by the product of the draught and hank roving, and subtract the quotient from 1. *Example:* Suppose No. 28.5 yarn is being spun from 4-hank roving, with a draught of 7.26. $7.26 \times 4 = 29.04$. $28.5 \div 29.4 = 0.98$, which subtracted from 1.00 leaves .02, or two per cent=the contraction in length.

To find the loss of twist in spinning:—

By the "loss of twist" is meant the amount the actual twist is less than that found by computing from the speed of the spindle. *Rule:* Divide 1 by the circumference of the bobbin in inches. *Example:* Suppose a filling bobbin is 1½ inches in circumference at the barrel. $1 \div 1.5 = 0.67$=loss there. If it is 3 inches in circumference at the outside the loss there $= 1 \div 3 = 0.33$. Average loss from computed twist 0.50, or half a turn per inch.

The best way to find the actual speed of spindles:—

Make some mark on the end of the cylinder so an assistant can turn it by hand slowly just once around. Mark the heads of several bobbins, or mark the whirls of the spindles, so as to be able to count the average number of turns of the spindle to one turn of the cylinder. Then multiply this number by the revolutions per minute the cylinder makes, ascertained carefully with a good speed-counter; or attach revolving-shaft of a speed-counter to tip of spindle with a rubber tube.

The result obtained by either of these methods is nearer the actual

speed of the spindle than the result obtained from computation in the usual way, because of the differences due to the size of the banding and the angle of the groove in the whirl.

To find the length of yarn in a bobbin:—

Multiply the circumference of the front roll in inches by the number of revolutions per minute, and this product by the number of minutes required to fill the bobbin; divide by 36 and deduct the contraction in twisting, and the result will be the number of yarns on the bobbin.

Avoirdupois Weight.

Grains.		Drachms.		Ounces.		Pounds.		Ton.		Grammes.		Kilog.
27.34	=	1							=	1.77184		
437.5	=	16	=	1					=	28.34954		
7,000.0	=	256	=	16	=	1			=	453.59265		
						2000	=	1			=	907.18

Long Measure.

Inches.		Feet.		Yards.		Rods.		Furlongs.		Mile.		Metres.
12	=	1									=	.3048
36	=	3	=	1							=	.9144
198	=	16.5	=	5.5	=	1					=	5.0291
7,920	=	660	=	220	=	40	=	1			=	201.1643
63,360	=	5,280	=	1,760	=	320	=	8		1	=	1,609.3145

DIMENSIONS OF CIRCLES.

Diameter.		Circumference.	Area.	Diameter.		Circumference.	Area.
1-64	.015625	.04909	.00019	3-4	.75	2.35619	.44179
1-32	.03125	.09817	.00077	25-32	.78125	2.45437	.47937
3-64	.046875	.14726	.00173	13-16	.8125	2.55254	.51849
1-16	.0625	.19635	.00307	27-32	.84375	2.65072	.55914
3-32	.09375	.29452	.00690	7-8	.875	2.74889	.60132
1-8	.125	.39270	.01227	29-32	.90625	2.84707	.64504
5-32	.15625	.49087	.01917	15-16	.9375	2.94524	.69029
3-16	.1875	.58905	.02761	31-32	.96875	3.04342	.73708
7-32	.21875	.68722	.03758	**1**		**3.14159**	**.78540**
1-4	.25	.78540	.04909	1-16	1.0625	3.33794	.88664
9-32	.28125	.88357	.06213	1-8	1.125	3.53429	.99402
5-16	.3125	.98175	.07670	3-16	1.1875	3.73064	1.1075
11-32	.34375	1.07992	.09281	1-4	1.25	3.92699	1.2272
3-8	.375	1.17810	.11045	5-16	1.3125	4.12334	1.3530
13-32	.40625	1.27627	.12962	3-8	1.375	4.31969	1.4849
7-16	.4375	1.37445	.15033	7-16	1.4375	4.51604	1.6230
15-32	.46875	1.47262	.17257	1-2	1.5	4.71239	1.7671
1-2	.5	1.57080	.19635	9-16	1.5625	4.90874	1.9175
17-32	.53125	1.66897	.22166	5-8	1.625	5.10509	2.0739
9-16	.5625	1.76715	.24850	11-16	1.6875	5.30144	2.2365
19-32	.59375	1.86532	.27688	3-4	1.75	5.49779	2.4053
5-8	.625	1.96350	.30680	13-16	1.8125	5.69414	2.5802
21-32	.65625	2.06167	.33824	7-8	1.875	5.89049	2.7612
11-16	.6875	2.15984	.37122	15-16	1.9375	6.08684	2.9483
23-32	.71875	2.25802	.40574	**2**		**6.28319**	**3.1416**

NUMBERING YARNS.

Yarn is weighed by avoirdupois weight.

Silk.

The silk-worm forms the cocoon of two parallel filaments of silk; three to six cocoons are usually reeled off together, making a thread of raw silk containing six to twelve filaments. One authority states that 500 yards of five twin filaments weigh about 2.5 grains. The number of drachms (27.34 grains) that 1000 yards of this raw silk weighs is the number.

Silk is sold in the United States by the number of yards in one ounce.

Sewing silk is numbered irregularly by letters:

Letter,	000	00	0	A	B	C	D	E	EE	F	FF	G
Yards in one oz.,	2000	1600	1300	1000	850	650	550	400	330	262	212	125

Letter A silk has 16,000 yards in a pound, and equals about a No. 60 cotton sewing thread in weight.

Silk that cannot be reeled is carded, spun and numbered like cotton yarn, and is called spun silk.

Linen and Jute.

Barlow's History of Weaving, London (1878), gives the following table:

2½ yards	=	1 thread or round of the linen reel.											
300	"	= 120	"	= 1	cut.								
600	"	= 240	"	= 2	"	= 1 heer.							
1,800	"	= 720	"	= 6	"	= 3	"	=1 slip.					
3,600	"	=1,440	"	=12	"	= 6	"	=2	"	=1 hank.			
7,200	"	=2,880	"	=24	"	=12	"	=4	"	=2	"	=1 hasp.	
14,400	"	=5,760	"	=48	"	=24	"	=8	"	=4	"	=2	" = 1 spyndle.

The number of cuts in one pound is the number of linen yarn.

The number of yards of linen yarn that weigh 23.33 grains is the number of the yarn.

The numbers by which linen sewing threads are sold represent three threads of the number twisted together, that is, No. 35 standard thread has three strands of No. 35 yarn in it.

Table for numbering Linen Yarn by the weight in grains of 300 yards or 1 lea (or cut).

Grains.	Number of yarn.	Grains.	Number of yarn.	Grains.	Number of yarn.	Grains.	Number of yarn.	Grains.	Number of yarn.	Grains.	Number of yarn.
100	70.	260	26.92	420	16.67	580	12.07	800	8.75	1500	4.67
110	63.64	270	25 93	430	16.28	590	11.86	825	8.48	1600	4.37
120	58.33	280	25.	440	15.91	600	11.67	850	8.24	1700	4.12
130	53.85	290	24.14	450	15.56	610	11.48	875	8.	1800	3.89
140	50.	300	23.33	460	15.22	620	11.29	900	7.78	1900	3.68
150	46.67	310	22.58	470	14.89	630	11.11	925	7.57	2000	3.50
160	43.75	320	21.87	480	14.58	640	10.94	950	7.37	2250	3.11
170	41.18	330	21.21	490	14.29	650	10.77	975	7.18	2500	2.80
180	38.89	340	20.59	500	14.	660	10.61	1000	7.	2750	2.55
190	36.84	350	20.	510	13.73	670	10.45	1050	6.67	3000	2.33
200	35.	360	19.44	520	13.46	680	10.29	1100	6.36	3250	2.15
210	33.33	370	18.92	530	13.21	690	10.14	1150	6.09	3500	2.
220	31.82	380	18.42	540	12.96	700	10.	1200	5.83	4000	1.75
230	30.43	390	17.95	550	12.73	725	9.66	1250	5.60	5000	1.40
240	29.17	400	17.50	560	12.50	750	9.33	1300	5.38	6000	1.17
250	28.	410	17.07	570	12.28	775	9.03	1400	5.	7000	1.

Woollen.

1 yard=1 thread or round of the woollen reel.
80 " =1 knot.
300 " =$3\frac{3}{4}$ " =1 cut.
1,600 " =20 " =$5\frac{1}{3}$ " =1 run.
2,000 " =25 " =$6\frac{2}{3}$ " =$1\frac{1}{4}$ " =1 bier.

The number of runs in one pound is the number of woollen yarn.

The number of yards of woollen yarn that weigh 4.375 grains is the number of the yarn.

Table for numbering Woollen Yarn by the weight in grains of twenty yards, or one fourth of a knot.

Grains.	Runs.	Grains.	Runs.	Grains.	Runs.	Grains.	Runs.	Grains.	Runs.	Grains.	Runs.
1	87.50	18	4.86	35	2.50	52	1.68	69	1.27	86	1.02
2	43.75	19	4.61	36	2.43	53	1.65	70	1.25	87	1.01
3	29.17	20	4.37	37	2.36	54	1.62	71	1.23	88	.99
4	21.87	21	4.17	38	2.30	55	1.59	72	1.22	89	.98
5	17.50	22	3.98	39	2.24	56	1.56	73	1.20	90	.97
6	14.58	23	3.80	40	2.19	57	1.54	74	1.18	91	.96
7	12.50	24	3.65	41	2.13	58	1.51	75	1.17	92	.95
8	10.94	25	3.50	42	2.08	59	1.48	76	1.15	93	.94
9	9.72	26	3.37	43	2.03	60	1.46	77	1.14	94	.93
10	8.75	27	3.24	44	1.99	61	1.43	78	1.12	95	.92
11	7.95	28	3.12	45	1.94	62	1.41	79	1.11	96	.91
12	7.29	29	3.02	46	1.90	63	1.38	80	1.09	97	.90
13	6.73	30	2.92	47	1.86	64	1.37	81	1.08	98	.89
14	6.25	31	2.82	48	1.82	65	1.35	82	1.07	99	.88
15	5.83	32	2.73	49	1.79	66	1.33	83	1.05	100	.87
16	5.47	33	2.65	50	1.75	67	1.31	84	1.04		
17	5.15	34	2.57	51	1.72	68	1.29	85	1.03		

The number of yarn of different sizes represents the proportionate size of No. 1 yarn, and to determine the size or number of a thread composed of strands of different numbers twisted together, it is only necessary to add together the proportionate sizes of the separate strands. A single example will illustrate: 3 run, 4 run, 5 run and 6 run twisted together will make yarn the size of $\frac{1}{3}\times\frac{1}{4}\times\frac{1}{5}\times\frac{1}{6}$ of 1 run, or $\frac{20}{60}\times\frac{15}{60}\times\frac{12}{60}\times\frac{10}{60}=\frac{57}{60}$ of 1 run; not quite so large as one run, but exactly $60\div57=1.05$ run.

Worsted.

1 yard, =1 thread or round of the worsted reel.
80 " =80 " =1 lea or knot.
560 " =560 " =7 " " =1 hank.

The number of hanks in one pound is the number of worsted yarn.

The number of a worsted yarn of a given length which equals in weight a cotton yarn of the same length, is equal to the cotton number multiplied by 1.5. No. 60 cotton No. 90 worsted.

The number of yards of worsted yarn that weigh 12.5 grains is the number of the yarn.

Table for numbering Worsted Yarn by the weight in grains of twenty yards, or one fourth of a knot.

Grains.	No. of Yarn.	Grains.	No. of Yarn.	Grains.	No. of Yarn.	Grains.	No. of Yarn.	Grains.	No. of Yarn.	Grains.	No. of Yarn.
1	250.	19	13.16	37	6.76	55	4.55	73	3.42	91	2.75
2	125.	20	12.50	38	6.58	56	4.46	74	3.38	92	2.72
3	83.33	21	11.90	39	6.41	57	4.39	75	3.33	93	2.69
4	62.50	22	11.36	40	6.25	58	4.31	76	3.29	94	2.66
5	50.	23	10.87	41	6.10	59	4.24	77	3.25	95	2.63
6	41.67	24	10.42	42	5.95	60	4.17	78	3.21	96	2.60
7	35.71	25	10.	43	5.81	61	4.10	79	3.17	97	2.58
8	31.25	26	9.62	44	5.68	62	4.03	80	3.12	98	2.55
9	27.78	27	9.26	45	5.56	63	3.97	81	3.09	99	2.52
10	25.	28	8.93	46	5.43	64	3.91	82	3.05	100	2.50
11	22.73	29	8.62	47	5.32	65	3.85	83	3.01	105	2.38
12	20.83	30	8.33	48	5.21	66	3.79	84	2.98	110	2.27
13	19.23	31	8.06	49	5.10	67	3.73	85	2.94	115	2.17
14	17.86	32	7.81	50	5.	68	3.68	86	2.91	120	2.08
15	16.67	33	7.58	51	4.90	69	3.62	87	2.87	125	2.
16	15.62	34	7.35	52	4.81	70	3.57	88	2.84	150	1.67
17	14.71	35	7.14	53	4.72	71	3.52	89	2.81	175	1.43
18	13.89	36	6.94	54	4.63	72	3.47	90	2.78	200	1.25

Cotton.

1½ yards =1 thread or round of the cotton reel.
120 " =80 " =1 skein, ley or lea.
840 " =560 " =7 skeins=1 hank.

The number of hanks in one pound, is the number of cotton yarn.

The number of yards of cotton yarn that weigh 8.33 grains, is the number of the yarn.

The numbers by which cotton sewing threads are sold represent three threads of the number twisted together, that is, No. 60 standard thread has three strands of No. 60 yarn in it. In a six-cord thread each of the three strands is made up of two threads twisted together. Six threads of No. 120 make six-cord No. 60.

The French system of numbering is based on the Metric system. The metre=39.37 inches, and is the standard of length. The kilogram (2.2047 pounds) is the standard weight in numbering yarn, and the number of thousand metres in a kilogram is the number of the yarn. No. 28 yarn would be No. 47.42 in France.

By the various standards, No. 1 yarn has the following numbers of yards in one pound:

Cotton and spun silk	840
Linen	300
Woollen	1,600
Worsted	560

The following tables have been carefully computed, and are, we believe, correct.

The tables for numbering cotton yarn by the weight of one skein are also printed separately for the use of spinners, and we will mail a copy to any overseer who will send to us for it, and give his address plainly written.

Comparative Numbers of Yarn of different materials of the same weight per yard.

Cot.	Woollen.	Worst.	Linen.	Silk.	Cot.	Woollen.	Worst.	Linen.	Silk.
Hanks of 840 yards.	Runs of 1,600 yards.	Hanks of 560 yards.	Cuts of 300 yards.	Yards in one ounce.	Hanks of 840 yards.	Runs of 1,600 yards.	Hanks of 560 yards.	Cuts of 300 yards.	Yards in one ounce.
1	.525	**1.5**	**2.8**	**52.5**	**71**	37.275	106.5	198.8	3727.5
2	1.05	3.	5.6	105.	**72**	37.8	108.	201.6	3780.
3	1.575	4.5	8.4	157.5	**73**	38.325	109.5	204.4	3832.5
4	2.1	6.	11.2	210.	**74**	38.85	111.	207.2	3885.
5	2.625	7.5	14.	262.5	**75**	39.375	112.5	210.	3937.5
6	3.15	9.	16.8	315.	**76**	39.9	114.	212.8	3990.
7	3.675	10.5	19.6	367.5	**77**	40.425	115.5	215.6	4042.5
8	4.2	12.	22.4	420.	**78**	40.95	117.	218.4	4095.
9	4.725	13.5	25.2	472.5	**79**	41.475	118.5	221.2	4147.5
10	5.25	15.	28.	525.	**80**	42.	120.	224.	4200.
11	5.775	16.5	30.8	577.5	**81**	42.525	121.5	226.8	4252.5
12	6.3	18.	33.6	630.	**82**	43.05	123.	229.6	4305.
13	6.825	19.5	36.4	682.5	**83**	43.575	124.5	232.4	4357.5
14	7.35	21.	39.2	735.	**84**	44.1	126.	235.2	4410.
15	7.875	22.5	42.	787.5	**85**	44.625	127.5	238.	4462.5
16	8.4	24.	44.8	840.	**86**	45.15	129.	240.8	4515.
17	8.925	25.5	47.6	892.5	**87**	45.675	130.5	243.6	4567.5
18	9.45	27.	50.4	945.	**88**	46.2	132.	246.4	4620.
19	9.975	28.5	53.2	997.5	**89**	46.725	133.5	249.2	4672.5
20	10.5	30.	56.	1050.	**90**	47.25	135.	252.	4725.
21	11.025	31.5	58.8	1102.5	**91**	47.775	136.5	254.8	4777.5
22	11.55	33.	61.6	1155.	**92**	48.3	138.	257.6	4830.
23	12.075	34.5	64.4	1207.5	**93**	48.825	139.5	260.4	4882.5
24	12.6	36.	67.2	1260.	**94**	49.35	141.	263.2	4935.
25	13.125	37.5	70.	1312.5	**95**	49.875	142.5	266.	4987.5
26	13.65	39.	72.8	1365.	**96**	50.4	144.	268.8	5040.
27	14.175	40.5	75.6	1417.5	**97**	50.925	145.5	271.6	5092.5
28	14.7	42.	78.4	1470.	**98**	51.45	147.	274.4	5145.
29	15.225	43.5	81.2	1522.5	**99**	51.975	148.5	277.2	5197.5
30	15.75	45.	84.	1575.	**100**	52.5	150.	280.	5250.
31	16.275	46.5	86.8	1627.5	**101**	53.025	151.5	282.8	5302.5
32	16.8	48.	89.6	1680.	**102**	53.55	153.	285.6	5355.
33	17.325	49.5	92.4	1732.5	**103**	54.075	154.5	288.4	5407.5
34	17.85	51.	95.2	1785.	**104**	54.6	156.	291.2	5460.
35	18.375	52.5	98.	1837.5	**105**	55.125	157.5	294.	5512.5
36	18.9	54.	100.8	1890.	**106**	55.65	159.	296.8	5565.
37	19.425	55.5	103.6	1942.5	**107**	56.175	160.5	299.6	5617.5
38	19.95	57.	106.4	1995.	**108**	56.7	162.	302.4	5670.
39	20.475	58.5	109.2	2047.5	**109**	57.225	163.5	305.2	5722.5
40	21.	60.	112.	2100.	**110**	57.75	165.	308.	5775.
41	21.525	61.5	114.8	2152.5	**111**	58.275	166.5	310.8	5827.5
42	22.05	63.	117.6	2205.	**112**	58.8	168.	313.6	5880.
43	22.575	64.5	120.4	2257.5	**113**	59.325	169.5	316.4	5932.5
44	23.1	66.	123.2	2310.	**114**	59.85	171.	319.2	5985.
45	23.625	67.5	126.	2362.5	**115**	60.375	173.5	322.	6037.5
46	24.15	69.	128.8	2415.	**116**	60.9	174.	324.8	6090.
47	24.675	70.5	131.6	2467.5	**117**	61.425	175.5	327.6	6142.5
48	25.2	72.	134.4	2520.	**118**	61.95	177.	330.4	6195.
49	25.725	73.5	137.2	2572.5	**119**	62.475	178.5	333.2	6247.5
50	26.25	75.	140.	2625.	**120**	63.	180.	336.	6300.
51	26.775	76.5	142.8	2677.5	**121**	63.525	181.5	338.8	6352.5
52	27.3	78.	145.6	2730.	**122**	64.05	183.	341.6	6405.
53	27.825	79.5	148.4	2782.5	**123**	64.575	184.5	344.4	6457.5
54	28.35	81.	151.2	2835.	**124**	65.1	186.	347.2	6510.
55	28.875	82.5	154.	2887.5	**125**	65.625	187.5	350.	6562.5
56	29.4	84.	156.8	2940.	**126**	66.15	189.	352.8	6615.
57	29.925	85.5	159.6	2992.5	**127**	66.675	190.5	355.6	6667.5
58	30.45	87.	162.4	3045.	**128**	67.2	192.	358.4	6720.
59	30.975	88.5	165.2	3097.5	**129**	67.725	193.5	361.2	6772.5
60	31.5	90.	168.	3150.	**130**	68.25	195.	364.	6825.
61	32.025	91.5	170.8	3202.5	**131**	68.775	196.5	366.8	6877.5
62	32.55	93.	173.6	3255.	**132**	69.3	198.	369.6	6930.
63	33.075	94.5	176.4	3307.5	**133**	69.825	199.5	372.4	6982.5
64	33.6	96.	179.2	3360.	**134**	70.35	201.	375.2	7035.
65	34.125	97.5	182.	3412.5	**135**	70.875	202.5	378.	7087.5
66	34.65	99.	184.8	3465.	**136**	71.4	204.	380.8	7140.
67	35.175	100.5	187.6	3517.5	**137**	71.925	205.5	383.6	7192.5
68	35.7	102.	190.4	3570.	**138**	72.45	207.	386.4	7245.
69	36.225	103.5	193.2	3622.5	**139**	72.975	208.5	389.2	7297.5
70	36.75	105.	196.	3675.	**140**	73.5	210.	392.	7350.

Table for numbering Cotton Yarn by the weight in grains of 120 yards or 1 skein.

120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.	120yds. weigh grains	Number of Yarn	120yds. weigh grains.	Number of Yarn.
1.	1000.	**14.**	71.43	**21**	47.62	**28.**	35.71	**35.**	28.57
2.	500.	.1	70.92	.1	47.39	.1	35.59	.1	28.49
3.	333.3	.2	70.42	.2	47.17	.2	35.46	.2	28.41
4.	250.0	.3	69.93	.3	46.95	.3	35.34	.3	28.33
5.	200.0	.4	69.44	.4	46.73	.4	35.21	.4	28.25
5.5	181.8	.5	68.97	.5	46.51	.5	35.09	.5	28.17
6.	166.7	.6	68.49	.6	46.30	.6	34.97	.6	28.09
6.5	153.8	.7	68.03	.7	46.08	.7	34.84	.7	28.01
7.	142.9	.8	67.57	.8	45.87	.8	34.72	.8	27.93
7.5	133.3	.9	67.11	.9	45.66	.9	34.60	.9	27.85
8.	125.0	**15.**	66.67	**22.**	45.45	**29.**	34.48	**36.**	27.78
.1	123.5	.1	66.23	.1	45.25	.1	34.36	.1	27.70
.2	122.0	.2	65.79	.2	45.05	.2	34.25	.2	27.62
.3	120.5	.3	65.36	.3	44.84	.3	34.13	.3	27.55
.4	119.0	.4	64.94	.4	44.64	.4	34.01	.4	27.47
.5	117.6	.5	64.52	.5	44.44	.5	33.90	.5	27.40
.6	116.3	.6	64.10	.6	44.25	.6	33.78	.6	27.32
.7	114.9	.7	63.69	.7	44.05	.7	33.67	.7	27.25
.8	113.6	.8	63.29	.8	43.86	.8	33.56	.8	27.17
.9	112.4	.9	62.89	.9	43.67	.9	33.44	.9	27.10
9.	111.1	**16.**	62.50	**23.**	43.48	**30.**	33.33	**37.**	27.03
.1	109.9	.1	62.11	.1	43.29	.1	33.22	.1	26.95
.2	108.7	.2	61.73	.2	43.10	.2	33.11	.2	26.88
.3	107.5	.3	61.35	.3	42.92	.3	33.00	.3	26.81
.4	106.4	.4	60.98	.4	42.74	.4	32.89	.4	26.74
.5	105.3	.5	60.61	.5	42.55	.5	32.79	.5	26.67
.6	104.2	.6	60.24	.6	42.37	.6	32.68	.6	26.60
.7	103.1	.7	59.88	.7	42.19	.7	32.57	.7	26.53
.8	102.0	.8	59.52	.8	42.02	.8	32.47	.8	26.46
.9	101.0	.9	59.17	.9	41.84	.9	32.36	.9	26.39
10	100.0	**17.**	58.82	**24.**	41.67	**31.**	32.26	**38.**	26.32
.1	99.01	.1	58.48	.1	41.49	.1	32.16	.1	26.25
.2	98.04	.2	58.14	.2	41.32	.2	32.05	.2	26.18
.3	97.09	.3	57.80	.3	41.15	.3	31.95	.3	26.11
.4	96.15	.4	57.47	.4	40.98	.4	31.85	.4	26.04
.5	95.24	.5	57.14	.5	40.82	.5	31.75	.5	25.97
.6	94.34	.6	56.82	.6	40.65	.6	31.65	.6	25.91
.7	93.46	.7	56.50	.7	40.49	.7	31.55	.7	25.84
.8	92.59	.8	56.18	.8	40.32	.8	31.45	.8	25.77
.9	91.74	.9	55.87	.9	40.16	.9	31.35	.9	25.71
11.	90.91	**18.**	55.56	**25.**	40.00	**32.**	31.25	**39.**	25.64
.1	90.09	.1	55.25	.1	39.84	.1	31.15	.1	25.58
.2	89.29	.2	54.95	.2	39.68	.2	31.06	.2	25.51
.3	88.50	.3	54.64	.3	39.53	.3	30.96	.3	25.45
.4	87.72	.4	54.35	.4	39.37	.4	30.86	.4	25.38
.5	86.96	.5	54.05	.5	39.22	.5	30.77	.5	25.32
.6	86.21	.6	53.76	.6	39.06	.6	30.67	.6	25.25
.7	85.47	.7	53.48	.7	38.91	.7	30.58	.7	25.19
.8	84.75	.8	53.19	.8	38.76	.8	30.49	.8	25.13
.9	84.03	.9	52.91	.9	38.61	.9	30.40	.9	25.06
12.	83.33	**19.**	52.63	**26.**	38.46	**33.**	30.30	**40.**	25.00
.1	82.64	.1	52.36	.1	38.31	.1	30.21	.1	24.94
.2	81.97	.2	52.08	.2	38.17	.2	30.12	.2	24.88
.3	81.30	.3	51.81	.3	38.02	.3	30.03	.3	24.81
.4	80.65	.4	51.55	.4	37.88	.4	29.94	.4	24.75
.5	80.00	.5	51.28	.5	37.74	.5	29.85	.5	24.69
.6	79.37	.6	51.02	.6	37.59	.6	29.76	.6	24.63
.7	78.74	.7	50.76	.7	37.45	.7	29.67	.7	24.57
.8	78.12	.8	50.51	.8	37.31	.8	29.59	.8	24.51
.9	77.52	.9	50.25	.9	37.17	.9	29.50	.9	24.45
13.	76.92	**20.**	50.00	**27.**	37.04	**34.**	29.41	**41.**	24.39
.1	76.34	.1	49.75	.1	36.90	.1	29.33	.1	24.33
.2	75.76	.2	49.50	.2	36.77	.2	29.24	.2	24.27
.3	75.19	.3	49.26	.3	36.63	.3	29.15	.3	24.21
.4	74.63	.4	49.02	.4	36.50	.4	29.07	.4	24.15
.5	74.07	.5	48.78	.5	36.36	.5	28.99	.5	24.10
.6	73.53	.6	48.54	.6	36.23	.6	28.90	.6	24.04
.7	72.99	.7	48.31	.7	36.10	.7	28.82	.7	23.98
.8	72.46	.8	48.08	.8	35.97	.8	28.74	.8	23.92
.9	71.94	.9	47.85	.9	35.84	.9	28.65	.9	23.87

Table for numbering Cotton Yarn by the weight in grains of 120 yards or 1 skein,

120yds weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.	120yds weigh grains.	Number of Yarn.	120yds weigh grains.	Number of Yarn.
42.	23.81	**49.**	20.41	**56.**	17.86	**63.**	15.87	**70.**	14.29
.1	23.75	.1	20.37	.1	17.83	.1	15.85	.1	14.27
.2	23.70	.2	20.33	.2	17.79	.2	15.83	.2	14.25
.3	23.64	.3	20.28	.3	17.76	.3	15.80	.3	14.22
.4	23.58	.4	20.24	.4	17.73	.4	15.77	.4	14.20
.5	23.53	.5	20.20	.5	17.70	.5	15.75	.5	14.18
.6	23.47	.6	20.16	.6	17.67	.6	15.72	.6	14.16
.7	23.42	.7	20.12	.7	17.64	.7	15.70	.7	14.14
.8	23.36	.8	20.08	.8	17.61	.8	15.67	.8	14.12
.9	23.31	.9	20.04	.9	17.57	.9	15.65	.9	14.10
43.	23.26	**50.**	20.00	**57.**	17.54	**64.**	15.62	**71.**	14.08
.1	23.20	.1	19.96	.1	17.51	.1	15.60	.1	14.06
.2	23.15	.2	19.92	.2	17.48	.2	15.58	.2	14.04
.3	23.09	.3	19.88	.3	17.45	.3	15.55	.3	14.03
.4	23.04	.4	19.84	.4	17.42	.4	15.53	.4	14.01
.5	22.99	.5	19.80	.5	17.39	.5	15.50	.5	13.99
.6	22.94	.6	19.76	.6	17.36	.6	15.48	.6	13.97
.7	22.88	.7	19.72	.7	17.33	.7	15.46	.7	13.95
.8	22.83	.8	19.69	.8	17.30	.8	15.43	.8	13.93
.9	22.78	.9	19.65	.9	17.27	.9	15.41	.9	13.91
44.	22.73	**51.**	19.61	**58.**	17.24	**65.**	15.38	**72.**	13.89
.1	22.68	.1	19.57	.1	17.21	.1	15.36	.1	13.87
.2	22.62	.2	19.53	.2	17.18	.2	15.34	.2	13.85
.3	22.57	.3	19.49	.3	17.15	.3	15.31	.3	13.83
.4	22.52	.4	19.46	.4	17.12	.4	15.29	.4	13.81
.5	22.47	.5	19.42	.5	17.09	.5	15.27	.5	13.79
.6	22.42	.6	19.38	.6	17.06	.6	15.24	.6	13.77
.7	22.37	.7	19.34	.7	17.04	.7	15.22	.7	13.76
.8	22.32	.8	19.31	.8	17.01	.8	15.20	.8	13.74
.9	22.27	.9	19.27	.9	16.98	.9	15.17	.9	13.72
45.	22.22	**52.**	19.23	**59.**	16.95	**66.**	15.15	**73.**	13.70
.1	22.17	.1	19.19	.1	16.92	.1	15.13	.1	13.68
.2	22.12	.2	19.16	.2	16.89	.2	15.11	.2	13.66
.3	22.08	.3	19.12	.3	16.86	.3	15.08	.3	13.64
.4	22.03	.4	19.08	.4	16.84	.4	15.06	.4	13.62
.5	21.98	.5	19.05	.5	16.81	.5	15.04	.5	13.61
.6	21.93	.6	19.01	.6	16.78	.6	15.02	.6	13.59
.7	21.88	.7	18.98	.7	16.75	.7	14.99	.7	13.57
.8	21.83	.8	18.94	.8	16.72	.8	14.97	.8	13.55
.9	21.79	.9	18.90	.9	16.69	.9	14.95	.9	13.53
46.	21.74	**53.**	18.87	**60.**	16.67	**67.**	14.93	**74.**	13.51
.1	21.69	.1	18.83	.1	16.64	.1	14.90	.1	13.50
.2	21.65	.2	18.80	.2	16.61	.2	14.88	.2	13.48
.3	21.60	.3	18.76	.3	16.58	.3	14.86	.3	13.46
.4	21.55	.4	18.73	.4	16.56	.4	14.84	.4	13.44
.5	21.51	.5	18.69	.5	16.53	.5	14.81	.5	13.42
.6	21.46	.6	18.66	.6	16.50	.6	14.79	.6	13.40
.7	21.41	.7	18.62	.7	16.47	.7	14.77	.7	13.39
.8	21.37	.8	18.59	.8	16.45	.8	14.75	.8	13.37
.9	21.32	.9	18.55	.9	16.42	.9	14.73	.9	13.35
47.	21.28	**54.**	18.52	**61.**	16.39	**68.**	14.71	**75.**	13.33
.1	21.23	.1	18.48	.1	16.37	.1	14.68	.1	13.32
.2	21.19	.2	18.45	.2	16.34	.2	14.66	.2	13.30
.3	21.14	.3	18.42	.3	16.31	.3	14.64	.3	13.28
.4	21.10	.4	18.38	.4	16.29	.4	14.62	.4	13.26
.5	21.05	.5	18.35	.5	16.26	.5	14.60	.5	13.25
.6	21.01	.6	18.32	.6	16.23	.6	14.58	.6	13.23
.7	20.96	.7	18.28	.7	16.21	.7	14.56	.7	13.21
.8	20.92	.8	18.25	.8	16.19	.8	14.53	.8	13.19
.9	20.88	.9	18.21	.9	16.16	.9	14.51	.9	13.18
48.	20.83	**55.**	18.18	**62.**	16.13	**69.**	14.49	**76.**	13.16
.1	20.79	.1	18.15	.1	16.10	.1	14.47	.1	13.14
.2	20.75	.2	18.12	.2	16.08	.2	14.45	.2	13.12
.3	20.70	.3	18.08	.3	16.05	.3	14.43	.3	13.11
.4	20.66	.4	18.05	.4	16.03	.4	14.41	.4	13.09
.5	20.62	.5	18.02	.5	16.00	.5	14.39	.5	13.07
.6	20.57	.6	17.99	.6	15.97	.6	14.37	.6	13.05
.7	20.53	.7	17.95	.7	15.95	.7	14.35	.7	13.04
.8	20.49	.8	17.92	.8	15.92	.8	14.33	.8	13.02
.9	20.45	.9	17.89	.9	15.90	.9	14.31	.9	13.00

Table for numbering Cotton Yarn by the weight in grains of 120 yards or 1 skein.

120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.
77.	12.99	**84.**	11.90	**91.**	10.99	**98.**	10.20	**105.**	9.52
.1	12.97	.1	11.89	.1	10.98	.1	10.19	.1	9.51
.2	12.95	.2	11.88	.2	10.96	.2	10.18	.2	9.51
.3	12.94	.3	11.86	.3	10.95	.3	10.17	.3	9.50
.4	12.92	.4	11.85	.4	10.94	.4	10.16	.4	9.49
.5	12.90	.5	11.83	.5	10.93	.5	10.15	.5	9.48
.6	12.89	.6	11.82	.6	10.92	.6	10.14	.6	9.47
.7	12.87	.7	11.81	.7	10.91	.7	10.13	.7	9.46
.8	12.85	.8	11.79	.8	10.89	.8	10.12	.8	9.45
.9	12.84	.9	11.78	.9	10.88	.9	10.11	.9	9.44
78.	12.82	**85.**	11.76	**92.**	10.87	**99.**	10.10	**106.**	9.43
.1	12.80	.1	11.75	.1	10.86	.1	10.09	.1	9.43
.2	12.79	.2	11.74	.2	10.85	.2	10.08	.2	9.42
.3	12.77	.3	11.72	.3	10.83	.3	10.07	.3	9.41
.4	12.76	.4	11.71	.4	10.82	.4	10.06	.4	9.40
.5	12.74	.5	11.70	.5	10.81	.5	10.05	.5	9.39
.6	12.72	.6	11.68	.6	10.80	.6	10.04	.6	9.38
.7	12.71	.7	11.67	.7	10.79	.7	10.03	.7	9.37
.8	12.69	.8	11.66	.8	10.78	.8	10.02	.8	9.36
.9	12.67	.9	11.64	.9	10.76	.9	10.01	.9	9.35
79.	12.66	**86.**	11.63	**93.**	10.75	**100.**	10.00	**107.**	9.35
.1	12.64	.1	11.61	.1	10.74	.1	9.99	.1	9.34
.2	12.63	.2	11.60	.2	10.73	.2	9.98	.2	9.33
.3	12.61	.3	11.59	.3	10.72	.3	9.97	.3	9.32
.4	12.59	.4	11.57	.4	10.71	.4	9.96	.4	9.31
.5	12.58	.5	11.56	.5	10.70	.5	9.95	.5	9.30
.6	12.56	.6	11.55	.6	10.68	.6	9.94	.6	9.29
.7	12.55	.7	11.53	.7	10.67	.7	9.93	.7	9.29
.8	12.53	.8	11.52	.8	10.66	.8	9.92	.8	9.28
.9	12.52	.9	11.51	.9	10.65	.9	9.91	.9	9.27
80.	12.50	**87.**	11.49	**94.**	10.64	**101.**	9.90	**108.**	9.26
.1	12.48	.1	11.48	.1	10.63	.1	9.89	.1	9.25
.2	12.47	.2	11.47	.2	10.62	.2	9.88	.2	9.24
.3	12.45	.3	11.45	.3	10.60	.3	9.87	.3	9.23
.4	12.44	.4	11.44	.4	10.59	.4	9.86	.4	9.23
.5	12.42	.5	11.43	.5	10.58	.5	9.85	.5	9.22
.6	12.41	.6	11.42	.6	10.57	.6	9.84	.6	9.21
.7	12.39	.7	11.40	.7	10.56	.7	9.83	.7	9.20
.8	12.38	.8	11.39	.8	10.55	.8	9.82	.8	9.19
.9	12.36	.9	11.38	.9	10.54	.9	9.81	.9	9.18
81.	12.35	**88.**	11.36	**95.**	10.53	**102.**	9.80	**109.**	9.17
.1	12.33	.1	11.35	.1	10.52	.1	9.79	.2	9.16
.2	12.32	.2	11.34	.2	10.50	.2	9.78	.4	9.14
.3	12.30	.3	11.33	.3	10.49	.3	9.78	.6	9.12
.4	12.29	.4	11.31	.4	10.48	.4	9.77	.8	9.11
.5	12.27	.5	11.30	.5	10.47	.5	9.76	110.	9.09
.6	12.25	.6	11.29	.6	10.46	.6	9.75	.2	9.07
.7	12.24	.7	11.27	.7	10.45	.7	9.74	.4	9.06
.8	12.22	.8	11.26	.8	10.44	.8	9.73	.6	9.04
.9	12.21	.9	11.25	.9	10.43	.9	9.72	.8	9.03
82.	12.20	**89.**	11.24	**96.**	10.42	**103.**	9.71	**111.**	9.01
.1	12.18	.1	11.22	.1	10.41	.1	9.70	.2	8.99
.2	12.17	.2	11.21	.2	10.40	.2	9.69	.4	8.98
.3	12.15	.3	11.20	.3	10.38	.3	9.68	.6	8.96
.4	12.14	.4	11.19	.4	10.37	.4	9.67	.8	8.94
.5	12.12	.5	11.17	.5	10.36	.5	9.66	112.	8.93
.6	12.11	.6	11.16	.6	10.35	.6	9.65	.2	8.91
.7	12.09	.7	11.15	.7	10.34	.7	9.64	.4	8.90
.8	12.08	.8	11.14	.8	10.33	.8	9.63	.6	8.88
.9	12.06	.9	11.12	.9	10.32	.9	9.62	.8	8.87
83.	12.05	**90.**	11.11	**97.**	10.31	**104.**	9.62	**113.**	8.85
.1	12.03	.1	11.10	.1	10.30	.1	9.61	.2	8.83
.2	12.02	.2	11.09	.2	10.29	.2	9.60	.4	8.82
.3	12.00	.3	11.07	.3	10.28	.3	9.59	.6	8.80
.4	11.99	.4	11.06	.4	10.27	.4	9.58	.8	8.79
.5	11.98	.5	11.05	.5	10.26	.5	9.57	114.	8.77
.6	11.96	.6	11.04	.6	10.25	.6	9.56	.2	8.76
.7	11.95	.7	11.03	.7	10.24	.7	9.55	.4	8.74
.8	11.93	.8	11.01	.8	10.22	.8	9.54	.6	8.73
.9	11.92	.9	11.00	.9	10.21	.9	9.53	.8	8.71

Table for numbering Cotton Yarn by the weight in grains of 120 yards or 1 skein.

120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn.	120yds. weigh grains.	Number of Yarn	120yds. weigh grains.	Number of Yarn.
115.	8.70	**140.**	7.14	**180.**	5.56	**250.**	4.00	**400.**	2.50
.2	8.68	.5	7.12	181.	5.52	252.	3.97	405.	2.47
.4	8.67	141.	7.09	182.	5.49	254.	3.94	410.	2.44
.6	8.65	.5	7.07	183.	5.46	256.	3.91	415.	2.41
.8	8.64	142.	7.04	184.	5.43	258.	3.88	420.	2.38
116.	8.62	.5	7.02	185.	5.41	260.	3.85	425.	2.35
.2	8.61	143.	6.99	186.	5.38	262.	3.82	430.	2.33
.4	8.59	.5	6.97	187.	5.35	264.	3.79	435.	2.30
.6	8.58	144.	6.94	188.	5.32	266.	3.76	440.	2.27
.8	8.56	.5	6.92	189.	5.29	268.	3.73	445.	2.25
117.	8.55	**145.**	6.90	**190.**	5.26	**270.**	3.70	**450.**	2.22
.2	8.53	.5	6.87	191.	5.24	272.	3.68	455.	2.20
.4	8.52	146.	6.85	192.	5.21	274.	3.65	460.	2.17
.6	8.50	.5	6.83	193.	5.18	276.	3.62	465.	2.15
.8	8.49	147.	6.80	194.	5.15	278.	3.60	470.	2.13
118.	8.47	.5	6.78	195.	5.13	280.	3.57	475.	2.11
.2	8.46	148.	6.76	196.	5.10	282.	3.55	480.	2.08
.4	8.45	.5	6.73	197.	5.08	284.	3.52	485.	2.06
.6	8.43	149.	6.71	198.	5.05	286.	3.50	490.	2.04
.8	8.42	.5	6.69	199.	5.03	288.	3.47	495.	2.02
119.	8.40	**150.**	6.67	**200.**	5.00	**290.**	3.45	**500.**	2.00
.2	8.39	.5	6.64	201.	4.98	292.	3.42	505.	1.98
.4	8.38	151.	6.62	202.	4.95	294.	3.40	510.	1.96
.6	8.36	.5	6.60	203.	4.93	296.	3.38	515.	1.94
.8	8.35	152.	6.58	204.	4.90	298.	3.36	520.	1.92
120.	8.33	.5	6.56	205.	4.88	300.	3.33	525.	1.90
.2	8.32	153.	6.54	206.	4.85	302.	3.31	530.	1.89
.4	8.31	.5	6.51	207.	4.83	304.	3.29	535.	1.87
.6	8.29	154.	6.49	208.	4.81	306.	3.27	540.	1.85
.8	8.28	.5	6.47	209.	4.78	308.	3.25	545.	1.83
121.	8.26	**155.**	6.45	**210.**	4.76	**310.**	3.23	**550.**	1.82
.4	8.24	.5	6.43	211.	4.74	312.	3.21	555.	1.80
.6	8.22	156.	6.41	212.	4.72	314.	3.18	560.	1.79
.8	8.21	.5	6.39	213.	4.69	316.	3.17	565.	1.77
122.	8.20	157.	6.37	214.	4.67	318.	3.14	570.	1.75
.5	8.16	.5	6.35	215.	4.65	320.	3.12	575.	1.74
123.	8.13	158.	6.33	216.	4.63	322.	3.11	580.	1.72
.5	8.10	.5	6.31	217.	4.61	324.	3.09	585.	1.71
124.	8.06	159.	6.29	218.	4.59	326.	3.07	590.	1.69
.5	8.03	.5	6.27	219.	4.57	328.	3.05	595.	1.68
125.	8.00	**160.**	6.25	**220.**	4.55	**330.**	3.03	**600.**	1.67
.5	7.97	.5	6.23	221.	4.52	332.	3.01	610.	1.64
126.	7.94	161.	6.21	222.	4.50	334.	2.99	620.	1.61
.5	7.91	.5	6.19	223.	4.48	336.	2.98	630.	1.59
127.	7.87	162.	6.17	224.	4.46	338.	2.96	640.	1.56
.5	7.84	.5	6.15	225.	4.44	340.	2.94	650.	1.54
128.	7.81	163.	6.13	226.	4.42	342.	2.92	660.	1.52
.5	7.78	.5	6.12	227.	4.41	344.	2.91	670.	1.49
129.	7.75	164.	6.10	228.	4.39	346.	2.89	680.	1.47
.5	7.72	.5	6.08	229.	4.37	348.	2.87	690.	1.45
130.	7.69	**165.**	6.06	**230.**	4.35	**350.**	2.86	**700.**	1.43
.5	7.66	.5	6.04	231.	4.33	352.	2.84	710.	1.41
131.	7.63	166.	6.02	232.	4.31	354.	2.82	720.	1.39
.5	7.60	.5	6.01	233.	4.29	356.	2.81	730.	1.37
132.	7.58	167.	5.99	234.	4.27	358.	2.79	740.	1.35
.5	7.55	.5	5.97	235.	4.26	360.	2.78	750.	1.33
133.	7.52	168.	5.95	236.	4.24	362.	2.76	760.	1.32
.5	7.49	.5	5.93	237.	4.22	364.	2.75	770.	1.30
134.	7.46	169.	5.92	238.	4.20	366.	2.73	780.	1.28
.5	7.43	.5	5.90	239.	4.18	368.	2.72	790.	1.27
135.	7.41	**170.**	5.88	**240.**	4.17	**370.**	2.70	**800.**	1.25
.5	7.38	171.	5.85	241.	4.15	372.	2.69	820.	1.22
136.	7.35	172.	5.81	242.	4.13	374.	2.67	840.	1.19
.5	7.33	173.	5.78	243.	4.12	376.	2.66	860.	1.16
137.	7.30	174.	5.75	244.	4.10	378.	2.65	880.	1.14
.5	7.27	175.	5.71	245.	4.08	380.	2.63	900.	1.11
138.	7.25	176.	5.68	246.	4.07	382.	2.62	925.	1.08
.5	7.22	177.	5.65	247.	4.05	385.	2.60	950.	1.05
139.	7.19	178.	5.62	248.	4.03	390.	2.56	975.	1.03
.5	7.17	179.	5.59	249.	4.02	395.	2.53	1000.	1.00

TWIST TABLE,

Showing the square root of the numbers or counts from 1 to 140 hanks in the pound, with the twist per inch for different kinds of yarn.

Counts or Numbers.	Square Root.	Ordinary Warp Twist.	Whitman's Warp Twist.	Extra Mule Warp Twist.	Mule Warp Twist.	Mule Filling Twist.
1	**1.0000**	**4.75**	**4.50**	**4.00**	**3.75**	**3.25**
2	1.4142	6.72	6.36	5.66	5.30	4.60
3	1.7321	8.23	7.79	6.93	6.50	5.63
4	2.0000	9.50	9.00	8.00	7.50	6.50
5	2.2361	10.62	10.06	8.94	8.39	7.27
6	2.4495	11.64	11.02	9.80	9.19	7.96
7	2.6458	12.57	11.91	10.58	9.92	8.60
8	2.8284	13.44	12.73	11.31	10.61	9.19
9	3.0000	14.25	13.50	12.00	11.25	9.75
10	3.1623	15.02	14.23	12.65	11.86	10.28
11	3.3166	15.75	14.92	13.27	12.44	10.78
12	3.4641	16.45	15.59	13.86	12.99	11.26
13	3.6056	17.13	16.22	14.42	13.52	11.72
14	3.7417	17.77	16.84	14.97	14.03	12.16
15	3.8730	18.40	17.43	15.49	14.52	12.59
16	4.0000	19.00	18.00	16.00	15.00	13.00
17	4.1231	19.58	18.55	16.49	15.46	13.40
18	4.2426	20.15	19.09	16.97	15.91	13.79
19	4.3589	20.70	19.62	17.44	16.35	14.17
20	4.4721	21.24	20.12	17.89	16.77	14.53
21	4.5826	21.77	20.62	18.33	17.18	14.89
22	4.6904	22.28	21.11	18.76	17.59	15.24
23	4.7958	22.78	21.58	19.18	17.98	15.59
24	4.8990	23.27	22.05	19.60	18.37	15.92
25	5.0000	23.75	22.50	20.00	18.75	16.25
26	5.0990	24.22	22.95	20.40	19.12	16.57
27	5.1962	24.68	23.38	20.78	19.49	16.89
28	5.2915	25.13	23.81	21.17	19.84	17.20
29	5.3852	25.58	24.23	21.54	20.19	17.50
30	5.4772	26.02	24.65	21.91	20.54	17.80
31	5.5678	26.45	25.05	22.27	20.88	18.10
32	5.6569	26.87	25.46	22.63	21.21	18.38
33	5.7446	27.29	25.85	22.98	21.54	18.67
34	5.8310	27.70	26.24	23.32	21.87	18.95
35	5.9161	28.10	26.62	23.66	22.19	19.23
36	6.0000	28.50	27.00	24.00	22.50	19.50
37	6.0828	28.89	27.37	24.33	22.81	19.77
38	6.1644	29.28	27.74	24.66	23.12	20.03
39	6.2450	29.66	28.10	24.98	23.42	20.30
40	6.3246	30.04	28.46	25.30	23.72	20.55
41	6.4031	30.41	28.81	25.61	24.01	20.81
42	6.4807	30.78	29.16	25.92	24.30	21.06
43	6.5574	31.15	29.51	26.23	24.59	21.31
44	6.6332	31.51	29.85	26.53	24.87	21.56
45	6.7082	31.86	30.19	26.83	25.16	21.80
46	6.7823	32.22	30.52	27.13	25.43	22.04
47	6.8557	32.56	30.85	27.42	25.71	22.28
48	6.9282	32.91	31.18	27.71	25.98	22.52
49	7.0000	33.25	31.50	28.00	26.25	22.75
50	7.0711	33.59	31.82	28.28	26.52	22.98
51	7.1414	33.92	32.14	28.57	26.78	23.21
52	7.2111	34.25	32.45	28.85	27.04	23.44
53	7.2801	34.58	32.76	29.12	27.30	23.66
54	7.3485	34.91	33.07	29.39	27.56	23.88
55	7.4162	35.23	33.37	29.66	27.81	24.10
56	7.4833	35.55	33.67	29.93	28.06	24.32
57	7.5498	35.86	33.97	30.20	28.31	24.54
58	7.6158	36.17	34.27	30.46	28.56	24.75
59	7.6811	36.49	34.57	30.72	28.80	24.96
60	7.7460	36.79	34.86	30.98	29.05	25.17
61	7.8102	37.10	35.15	31.24	29.29	25.38
62	7.8740	37.40	35.43	31.50	29.53	25.59
63	7.9373	37.70	35.72	31.75	29.76	25.80
64	8.0000	38.00	36.00	32.00	30.00	26.00
65	8.0623	38.30	36.28	32.25	30.23	26.20
66	8.1240	38.59	36.56	32.50	30.47	26.40
67	8.1854	38.88	36.83	32.74	30.70	26.60
68	8.2462	39.17	37.11	32.98	30.92	26.80
69	8.3066	39.46	37.38	33.23	31.15	27.00
70	8.3666	39.74	37.65	33.47	31.37	27.19

TWIST TABLE.

Counts or Numbers.	Square Root.	Ordinary Warp Twist.	Whitman's Warp Twist.	Extra Mule Warp Twist.	Mule Warp Twist.	Mule Filling Twist.
1	**1.0000**	**4.75**	**4.50**	**4.00**	**3.75**	**3.25**
71	8.4261	40.02	37.92	33.70	31.60	27.38
72	8.4853	40.31	38.18	33.94	31.82	27.58
73	8.5440	40.58	38.45	34.18	32.04	27.77
74	8.6023	40.86	38.71	34.41	32.26	27.96
75	8.6603	41.14	38.97	34.64	32.48	28.15
76	8.7178	41.41	39.23	34.87	32.69	28.33
77	8.7750	41.68	39.49	35.10	32.91	28.52
78	8.8318	41.95	39.74	35.33	33.12	28.70
79	8.8882	42.22	40.00	35.55	33.33	28.89
80	8.9443	42.49	40.25	35.78	33.54	29.07
81	9.0000	42.75	40.50	36.00	33.75	29.25
82	9.0554	43.01	40.75	36.22	33.96	29.43
83	9.1104	43.27	41.00	36.44	34.16	29.61
84	9.1652	43.53	41.24	36.66	34.37	29.79
85	9.2195	43.79	41.49	36.88	34.57	29.96
86	9.2736	44.05	41.73	37.09	34.78	30.14
87	9.3274	44.31	41.97	37.31	34.98	30.31
88	9.3808	44.56	42.21	37.52	35.18	30.49
89	9.4340	44.81	42.45	37.74	35.38	30.66
90	9.4868	45.06	42.69	37.95	35.58	30.83
91	9.5394	45.31	42.93	38.16	35.77	31.00
92	9.5917	45.56	43.16	38.37	35.97	31.17
93	9.6437	45.81	43.40	38.57	36.16	31.34
94	9.6954	46.05	43.63	38.78	36.36	31.51
95	9.7468	46.30	43.86	38.99	36.55	31.68
96	9.7980	46.54	44.09	39.19	36.74	31.84
97	9.8489	46.78	44.32	39.40	36.93	32.01
98	9.8995	47.02	44.55	39.60	37.12	32.17
99	9.9499	47.26	44.77	39.80	37.31	32.34
100	10.0000	47.50	45.00	40.00	37.50	32.50
101	10.0499	47.74	45.22	40.20	37.69	32.66
102	10.0995	47.97	45.45	40.40	37.87	32.82
103	10.1489	48.21	45.67	40.60	38.06	32.98
104	10.1980	48.44	45.89	40.79	38.24	33.14
105	10.2470	48.67	46.11	40.99	38.43	33.30
106	10.2956	48.90	46.33	41.18	38.61	33.46
107	10.3441	49.13	46.55	41.38	38.79	33.62
108	10.3973	49.36	46.77	41.57	38.97	33.77
109	10.4403	49.59	46.98	41.76	39.15	33.93
110	10.4881	49.82	47.20	41.95	39.33	34.09
111	10.5357	50.04	47.41	42.14	39.51	34.24
112	10.5830	50.27	47.62	42.33	39.69	34.39
113	10.6301	50.49	47.84	42.52	39.86	34.55
114	10.6771	50.72	48.05	42.71	40.04	34.70
115	10.7238	50.94	48.26	42.90	40.21	34.85
116	10.7703	51.16	48.47	43.08	40.39	35.00
117	10.8167	51.38	48.67	43.27	40.56	35.15
118	10.8628	51.60	48.88	43.45	40.74	35.30
119	10.9087	51.82	49.09	43.63	40.91	35.45
120	10.9545	52.03	49.30	43.82	41.08	35.60
121	11.0000	52.25	49.50	44.00	41.25	35.75
122	11.0454	52.47	49.70	44.18	41.42	35.90
123	11.0905	52.68	49.91	44.36	41.59	36.04
124	11.1355	52.89	50.11	44.54	41.73	36.19
125	11.1803	53.11	50.31	44.72	41.93	36.34
126	11.2250	53.32	50.51	44.90	42.09	36.48
127	11.2694	53.53	50.71	45.08	42.26	36.63
128	11.3137	53.74	50.91	45.25	42.43	36.77
129	11.3578	53.95	51.12	45.43	42.59	36.91
130	11.4018	54.16	51.31	45.61	42.76	37.06
131	11.4455	54.37	51.50	45.78	42.92	37.20
132	11.4891	54.57	51.70	45.96	43.08	37.34
133	11.5326	54.78	51.90	46.13	43.25	37.48
134	11.5758	54.99	52.09	46.30	43.41	37.62
135	11.6190	55.19	52.29	46.48	43.57	37.76
136	11.6619	55.39	52.48	46.65	43.73	37.90
137	11.7047	55.60	52.67	46.82	43.89	38.04
138	11.7473	55.80	52.86	47.99	44.05	38.18
139	11.7898	56.00	53.05	47.16	44.21	38.32
140	11.8322	56.20	53.24	47.33	44.37	38.45

TWO PLY.

No. of yarn to be twist'd.	No. of twisted yarn.	Sq. root of No. twisted yarn.	Square root multiplied by		
			4	5	6
1	.5	.7071	2.83	3.54	4.24
2	1.	1.	4.	5.	6.
3	1.5	1.2247	4.90	6.12	7.35
4	2.	1.4142	5.66	7.07	8.49
5	2.5	1.5811	6.32	7.91	9.49
6	3.	1.7321	6.93	8.66	10.39
7	3.5	1.8708	7.48	9.35	11.22
8	4.	2.	8.	10.	12.
9	4.5	2.1213	8.49	10.61	12.73
10	5.	2.2361	8.94	11.18	13.42
11	5.5	2.3452	9.38	11.73	14.07
12	6.	2.4495	9.80	12.25	14.70
13	6.5	2.5495	10.20	12.75	15.30
14	7.	2.6458	10.58	13.23	15.87
15	7.5	2.7386	10.95	13.69	16.43
16	8.	2.8284	11.31	14.14	16.97
17	8.5	2.9155	11.66	14.58	17.49
18	9.	3.	12.	15.	18.
19	9.5	3.0822	12.33	15.41	18.49
20	10.	3.1623	12.65	15.81	18.97
21	10.5	3.2404	12.96	16.20	19.44
22	11.	3.3166	13.27	16.58	19.90
23	11.5	3.3912	13.56	16.96	20.35
24	12.	3.4641	13.86	17.32	20.78
25	12.5	3.5355	14.14	17.68	21.21
26	13.	3.6056	14.42	18.03	21.63
27	13.5	3.6742	14.70	18.37	22.05
28	14.	3.7417	14.97	18.71	22.45
29	14.5	3.8079	15.23	19.04	22.85
30	15.	3.8730	15.49	19.37	23.24
31	15.5	3.9370	15.75	19.69	23.62
32	16.	4.	16.	20.	24.
33	16.5	4.0620	16.25	20.31	24.37
34	17.	4.1231	16.49	20.62	24.74
35	17.5	4.1833	16.73	20.92	25.10
36	18.	4.2426	16.97	21.21	25.46
37	18.5	4.3012	17.20	21.51	25.81
38	19.	4.3589	17.44	21.79	26.15
39	19.5	4.4159	17.66	22.08	26.50
40	20.	4.4721	17.89	22.36	26.83
41	20.5	4.5277	18.11	22.64	27.17
42	21.	4.5826	18.33	22.91	27.50
43	21.5	4.6368	18.55	23.18	27.82
44	22.	4.6904	18.76	23.45	28.14
45	22.5	4.7434	18.97	23.72	28.46
46	23.	4.7958	19.18	23.98	28.77
47	23.5	4.8477	19.39	24.24	29.09
48	24.	4.8990	19.60	24.49	29.39
49	24.5	4.9497	19.80	24.75	29.70
50	25.	5.	20.	25.	30.
51	25.5	5.0498	20.20	25.25	30.30
52	26.	5.0990	20.40	25.50	30.59
53	26.5	5.1478	20.59	25.74	30.89
54	27.	5.1962	20.78	25.98	31.18
55	27.5	5.2440	20.98	26.22	31.46
56	28.	5.2915	21.17	26.46	31.75
57	28.5	5.3385	21.35	26.69	32.03
58	29.	5.3852	21.54	26.93	32.31
59	29.5	5.4314	21.73	27.16	32.59
60	30.	5.4772	21.91	27.39	32.86
61	30.5	5.5227	22.09	27.61	33.14
62	31.	5.5678	22.27	27.84	33.41
63	31.5	5.6125	22.45	28.06	33.67
64	32.	5.6569	22.63	28.28	33.94
65	32.5	5.7009	22.80	28.50	34.21
66	33.	5.7446	22.98	28.72	34.47
67	33.5	5.7879	23.15	28.94	34.73
68	34.	5.8310	23.32	29.15	34.99
69	34.5	5.8737	23.49	29.37	35.24
70	35.	5.9161	23.66	29.58	35.50
71	35.5	5.9582	23.83	29.79	35.75
72	36.	6.	24.	30.	36.
73	36.5	6.0415	24.17	30.21	36.25
74	37.	6.0828	24.33	30.41	36.50
75	37.5	6.1237	24.49	30.62	36.74

No. of yarn to be twist'd	No. of twisted yarn.	Sq. root of No. twisted yarn.	Square root multiplied by	
			5	6
76	38.	6.1644	30.82	36.99
77	38.5	6.2049	31.02	37.23
78	39.	6.2450	31.22	37.47
79	39.5	6.2849	31.42	37.71
80	40.	6.3246	31.62	37.95
81	40.5	6.3640	31.82	38.18
82	41.	6.4031	32.02	38.42
83	41.5	6.4420	32.21	38.65
84	42.	6.4807	32.40	38.88
85	42.5	6.5192	32.60	39.12
86	43.	6.5574	32.79	39.34
87	43.5	6.5955	32.98	39.57
88	44.	6.6332	33.17	39.80
89	44.5	6.6708	33.35	40.02
90	45.	6.7082	33.54	40.25
91	45.5	6.7454	33.73	40.47
92	46.	6.7823	33.91	40.69
93	46.5	6.8191	34.10	40.91
94	47.	6.8557	34.28	41.13
95	47.5	6.8920	34.46	41.35
96	48.	6.9282	34.64	41.57
97	48.5	6.9642	34.82	41.79
98	49.	7.	35.	42.
99	49.5	7.0356	35.18	42.21
100	50.	7.0711	35.36	42.43
101	50.5	7.1063	35.53	42.64
102	51.	7.1414	35.70	42.85
103	51.5	7.1763	35.88	43.06
104	52.	7.2111	36.06	43.27
105	52.5	7.2457	36.23	43.47
106	53.	7.2801	36.40	43.68
107	53.5	7.3144	36.57	43.89
108	54.	7.3485	36.74	44.09
109	54.5	7.3824	36.91	44.29
110	55.	7.4162	37.08	44.50
111	55.5	7.4498	37.25	44.70
112	56.	7.4833	37.42	44.90
113	56.5	7.5166	37.58	45.10
114	57.	7.5498	37.75	45.30
115	57.5	7.5829	37.91	45.50
116	58.	7.6158	38.08	45.69
117	58.5	7.6485	38.24	45.89
118	59.	7.6811	38.41	46.09
119	59.5	7.7136	38.57	46.28
120	60.	7.7460	38.73	46.48
121	60.5	7.7782	38.89	46.67
122	61.	7.8102	39.05	46.86
123	61.5	7.8422	39.21	47.05
124	62.	7.8740	39.37	47.24
125	62.5	7.9057	39.53	47.43
126	63.	7.9373	39.69	47.62
127	63.5	7.9687	39.84	47.81
128	64.	8.	40.	48.
129	64.5	8.0312	40.16	48.19
130	65.	8.0623	40.31	48.37
131	65.5	8.0932	40.47	48.56
132	66.	8.1240	40.62	48.74
133	66.5	8.1548	40.77	48.93
134	67.	8.1854	40.93	49.11
135	67.5	8.2158	41.08	49.30
136	68.	8.2462	41.23	49.48
137	68.5	8.2765	41.38	49.66
138	69.	8.3066	41.53	49.84
139	69.5	8.3367	41.68	50.02
140	70.	8.3666	41.83	50.20
141	70.5	8.3964	41.98	50.38
142	71.	8.4261	42.13	50.56
143	71.5	8.4558	42.28	50.73
144	72.	8.4853	42.43	50.91
145	72.5	8.5147	42.57	51.09
146	73.	8.5440	42.72	51.26
147	73.5	8.5732	42.87	51.44
148	74.	8.6023	43.01	51.61
149	74.5	8.6313	43.16	51.79
150	75.	8.6603	43.30	51.96

THREE PLY.

No. of yarn to be twist'd.	No. of twisted yarn.	Sq. root of No. twisted yarn.	Square root multiplied by			No. of yarn to be twist'd.	No. of twisted yarn.	Sq. root of No. twisted yarn.	Square root multiplied by	
			4	5	6				5	6
1	.33	.5774	2.31	2.89	3.46	76	25.33	5.0332	25.17	30.20
2	.67	.8165	3.27	4.08	4.90	77	25.67	5.0662	25.33	30.40
3	1.	1.	4.	5.	6.	78	26.	5.0990	25.50	30.59
4	1.33	1.1547	4.62	5.77	6.93	79	26.33	5.1316	25.66	30.79
5	1.67	1.2910	5.16	6.45	7.75	**80**	26.67	5.1640	25.82	30.98
6	2.	1.4142	5.66	7.07	8.49	81	27.	5.1962	25.98	31.18
7	2.33	1.5275	6.11	7.64	9.17	82	27.33	5.2281	26.14	31.37
8	2.67	1.6330	6.53	8.16	9.80	83	27.67	5.2599	26.30	31.56
9	3.	1.7321	6.93	8.66	10.39	84	28.	5.2915	26.46	31.75
10	3.33	1.8257	7.30	9.13	10.95	85	28.33	5.3229	26.61	31.94
11	3.67	1.9149	7.66	9.57	11.49	86	28.67	5.3541	26.77	32.12
12	4.	2.	8.	10.	12.	87	29.	5.3852	26.93	32.31
13	4.33	2.0817	8.33	10.41	12.49	88	29.33	5.4160	27.08	32.50
14	4.67	2.1602	8.64	10.80	12.96	89	29.67	5.4467	27.23	32.68
15	5.	2.2361	8.94	11.18	13.42	**90**	30.	5.4772	27.39	32.86
16	5.33	2.3094	9.24	11.55	13.86	91	30.33	5.5076	27.54	33.05
17	5.67	2.3805	9.52	11.90	14.28	92	30.67	5.5377	27.69	33.23
18	6.	2.4495	9.80	12.25	14.70	93	31.	5.5678	27.84	33.41
19	6.33	2.5166	10.07	12.58	15.10	94	31.33	5.5976	27.99	33.59
20	6.67	2.5820	10.33	12.91	15.49	95	31.67	5.6273	28.14	33.76
21	7.	2.6458	10.58	13.23	15.87	96	32.	5.6569	28.28	33.94
22	7.33	2.7080	10.83	13.54	16.25	97	32.33	5.6862	28.43	34.12
23	7.67	2.7689	11.08	13.84	16.61	98	32.67	5.7155	28.58	34.29
24	8.	2.8284	11.31	14.14	16.97	99	33.	5.7446	28.72	34.47
25	8.33	2.8868	11.55	14.43	17.32	**100**	33.33	5.7735	28.87	34.64
26	8.67	2.9439	11.76	14.72	17.66	101	33.67	5.8023	29.01	34.81
27	9.	3.	12.	15.	18.	102	34.	5.8310	29.15	34.99
28	9.33	3.0551	12.22	15.28	18.33	103	34.33	5.8595	29.30	35.16
29	9.67	3.1091	12.44	15.55	18.65	104	34.67	5.8878	29.44	35.33
30	10.	3.1623	12.65	15.81	18.97	105	35.	5.9161	29.58	35.50
31	10.33	3.2145	12.86	16.07	19.29	106	35.33	5.9442	29.72	35.67
32	10.67	3.2659	13.06	16.33	19.60	107	35.67	5.9722	29.86	35.83
33	11.	3.3166	13.27	16.58	19.90	108	36.	6.	30.	36.
34	11.33	3.3665	13.47	16.83	20.20	109	36.33	6.0277	30.14	36.17
35	11.67	3.4157	13.66	17.08	20.49	**110**	36.67	6.0553	30.28	36.33
36	12.	3.4641	13.86	17.32	20.78	111	37.	6.0828	30.41	36.50
37	12.33	3.5119	14.05	17.56	21.07	112	37.33	6.1101	30.55	36.66
38	12.67	3.5590	14.24	17.80	21.35	113	37.67	6.1374	30.69	36.83
39	13.	3.6056	14.42	18.03	21.63	114	38.	6.1644	30.82	36.99
40	13.33	3.6515	14.61	18.26	21.91	115	38.33	6.1914	30.96	37.15
41	13.67	3.6969	14.79	18.48	22.18	116	38.67	6.2183	31.09	37.31
42	14.	3.7417	14.97	18.71	22.45	117	39.	6.2450	31.22	37.47
43	14.33	3.7859	15.14	18.93	22.72	118	39.33	6.2716	31.36	37.63
44	14.67	3.8297	15.32	19.15	22.98	119	39.67	6.2981	31.49	37.79
45	15.	3.8730	15.49	19.36	23.24	**120**	40.	6.3246	31.62	37.95
46	15.33	3.9158	15.66	19.58	23.49	121	40.33	6.3509	31.75	38.11
47	15.67	3.9582	15.83	19.79	23.75	122	40.67	6.3770	31.89	38.26
48	16.	4.	16.	20.	24.	123	41.	6.4031	32.02	38.42
49	16.33	4.0415	16.17	20.21	24.25	124	41.33	6.4291	32.15	38.57
50	16.67	4.0825	16.33	20.41	24.49	125	41.67	6.4550	32.27	38.73
51	17.	4.1231	16.49	20.62	24.74	126	42.	6.4807	32.40	38.88
52	17.33	4.1633	16.65	20.82	24.98	127	42.33	6.5064	32.53	39.04
53	17.67	4.2032	16.81	21.02	25.22	128	42.67	6.5320	32.66	39.19
54	18.	4.2426	16.97	21.21	25.46	129	43.	6.5574	32.79	39.34
55	18.33	4.2817	17.13	21.41	25.69	**130**	43.33	6.5828	32.91	39.50
56	18.67	4.3205	17.28	21.60	25.92	131	43.67	6.6081	33.04	39.65
57	19.	4.3589	17.44	21.79	26.15	132	44.	6.6332	33.17	39.80
58	19.33	4.3970	17.59	21.98	26.38	133	44.33	6.6583	33.29	39.95
59	19.67	4.4347	17.74	22.17	26.61	134	44.67	6.6833	33.42	40.10
60	20.	4.4721	17.89	22.36	26.83	135	45.	6.7082	33.54	40.25
61	20.33	4.5092	18.04	22.55	27.06	136	45.33	6.7330	33.67	40.40
62	20.67	4.5461	18.18	22.73	27.28	137	45.67	6.7577	33.79	40.55
63	21.	4.5826	18.33	22.91	27.50	138	46.	6.7823	33.91	40.69
64	21.33	4.6188	18.48	23.09	27.71	139	46.33	6.8069	34.03	40.84
65	21.67	4.6547	18.62	23.27	27.93	**140**	46.67	6.8313	34.16	40.99
66	22.	4.6904	18.76	23.45	28.14	141	47.	6.8557	34.28	41.13
67	22.33	4.7258	18.90	23.63	28.35	142	47.33	6.8799	34.40	41.28
68	22.67	4.7610	19.04	23.80	28.57	143	47.67	6.9041	34.52	41.42
69	23.	4.7958	19.18	23.98	28.77	144	48.	6.9282	34.64	41.57
70	23.33	4.8305	19.32	24.15	28.98	145	48.33	6.9522	34.76	41.71
71	23.67	4.8648	19.46	24.32	29.19	146	48.67	6.9762	34.88	41.86
72	24.	4.8990	19.60	24.49	29.39	147	49.	7.	35.	42.
73	24.33	4.9329	19.73	24.66	29.60	148	49.33	7.0238	35.12	42.14
74	24.67	4.9666	19.87	24.83	29.80	149	49.67	7.0475	35.24	42.28
75	25.	5.	20.	25.	30.	**150**	50.	7.0711	35.36	42.43

FOUR PLY.

No. of yarn to be twist'd.	No. of twisted yarn.	Sq. root of No. twisted yarn.	Square root multiplied by 4	5	6
1	.25	.5	2.	2.5	3.
2	.50	.7071	2.83	3.54	4.24
3	.75	.8660	3.46	4.33	5.20
4	1.	1.	4.	5.	6.
5	.25	1.1180	4.47	5.59	6.71
6	.50	1.2247	4.90	6.12	7.35
7	.75	1.3229	5.29	6.61	7.94
8	2.	1.4142	5.66	7.07	8.49
9	.25	1.5	6.	7.5	9.
10	.50	1.5811	6.32	7.91	9.49
11	.75	1.6583	6.63	8.29	9.95
12	3.	1.7321	6.93	8.66	10.39
13	.25	1.8028	7.21	9.01	10.82
14	.50	1.8708	7.48	9.35	11.22
15	.75	1.9365	7.75	9.68	11.62
16	4.	2.	8.	10.	12.
17	.25	2.0616	8.25	10.31	12.37
18	.50	2.1213	8.49	10.61	12.73
19	.75	2.1794	8.72	10.90	13.08
20	5.	2.2361	8.94	11.18	13.42
21	.25	2.2913	9.17	11.46	13.75
22	.50	2.3452	9.38	11.73	14.07
23	.75	2.3979	9.59	11.99	14.39
24	6.	2.4495	9.80	12.25	14.70
25	.25	2.5	10.	12.5	15.
26	.50	2.5495	10.20	12.75	15.30
27	.75	2.5981	10.39	12.99	15.59
28	7.	2.6458	10.58	13.23	15.87
29	.25	2.6926	10.77	13.46	16.16
30	.50	2.7386	10.95	13.69	16.43
31	.75	2.7839	11.14	13.92	16.70
32	8.	2.8284	11.31	14.14	16.97
33	.25	2.8723	11.49	14.36	17.23
34	.50	2.9155	11.66	14.58	17.49
35	.75	2.9580	11.83	14.79	17.75
36	9.	3.	12.	15.	18.
37	.25	3.0414	12.17	15.21	18.25
38	.50	3.0822	12.33	15.41	18.49
39	.75	3.1225	12.49	15.61	18.73
40	10.	3.1623	12.65	15.81	18.97
41	.25	3.2016	12.81	16.01	19.21
42	.50	3.2404	12.96	16.20	19.44
43	.75	3.2787	13.11	16.39	19.67
44	11.	3.3166	13.27	16.58	19.90
45	.25	3.3541	13.42	16.77	20.12
46	.50	3.3912	13.56	16.96	20.35
47	.75	3.4278	13.71	17.14	20.57
48	12.	3.4641	13.86	17.32	20.78
49	.25	3.5	14.	17.5	21.
50	.50	3.5355	14.14	17.68	21.21
51	.75	3.5707	14.28	17.85	21.42
52	13.	3.6056	14.42	18.03	21.63
53	.25	3.6401	14.56	18.20	21.84
54	.50	3.6742	14.70	18.37	22.05
55	.75	3.7081	14.83	18.54	22.25
56	14.	3.7417	14.97	18.71	22.45
57	.25	3.7749	15.10	18.87	22.65
58	.50	3.8079	15.23	19.04	22.85
59	.75	3.8406	15.36	19.20	23.04
60	15.	3.8730	15.49	19.37	23.24
61	.25	3.9051	15.62	19.53	23.43
62	.50	3.9370	15.75	19.69	23.62
63	.75	3.9686	15.88	19.84	23.81
64	16.	4.	16.	20.	24.
65	.25	4.0311	16.12	20.16	24.19
66	.50	4.0620	16.25	20.31	24.37
67	.75	4.0927	16.37	20.46	24.56
68	17.	4.1231	16.49	20.62	24.74
69	.25	4.1533	16.61	20.77	24.92
70	.50	4.1833	16.73	20.92	25.10
71	.75	4.2130	16.85	21.07	25.28
72	18.	4.2426	16.97	21.21	25.46
73	.25	4.2720	17.09	21.36	25.63
74	.50	4.3012	17.20	21.51	25.81
75	.75	4.3301	17.32	21.65	25.98
76	19.	4.3589	21.79	26.15
77	.25	4.3875	21.94	26.32
78	.50	4.4159	22.08	26.50
79	.75	4.4441	22.22	26.66
80	20.	4.4721	22.36	26.83
81	.25	4.5	22.5	27.
82	.50	4.5277	22.64	27.17
83	.75	4.5552	22.78	27.33
84	21.	4.5826	22.91	27.50
85	.25	4.6098	23.05	27.66
86	.50	4.6368	23.18	27.82
87	.75	4.6637	23.32	27.98
88	22.	4.6904	23.45	28.14
89	.25	4.7170	23.58	28.30
90	.50	4.7434	23.72	28.46
91	.75	4.7697	23.85	28.62
92	23.	4.7958	23.98	28.77
93	.25	4.8218	24.11	28.93
94	.50	4.8477	24.24	29.09
95	.75	4.8734	24.37	29.24
96	24.	4.8990	24.49	29.39
97	.25	4.9244	24.62	29.55
98	.50	4.9497	24.75	29.70
99	.75	4.9749	24.87	29.85
100	25.	5.	25.	30.
101	.25	5.0249	25.12	30.15
102	.50	5.0498	25.25	30.30
103	.75	5.0744	25.37	30.45
104	26.	5.0990	25.50	30.59
105	.25	5.1235	25.62	30.74
106	.50	5.1478	25.74	30.89
107	.75	5.1720	25.86	31.03
108	27.	5.1962	25.98	31.18
109	.25	5.2202	26.10	31.32
110	.50	5.2440	26.22	31.46
111	.75	5.2678	26.34	31.61
112	28.	5.2915	26.46	31.75
113	.25	5.3151	26.58	31.89
114	.50	5.3385	26.69	32.03
115	.75	5.3619	26.81	32.17
116	29.	5.3852	26.93	32.31
117	.25	5.4083	27.04	32.45
118	.50	5.4314	27.16	32.59
119	.75	5.4543	27.27	32.73
120	30.	5.4772	27.39	32.86
121	.25	5.5	27.5	33.
122	.50	5.5227	27.61	33.14
123	.75	5.5453	27.73	33.27
124	31.	5.5678	27.84	33.41
125	.25	5.5902	27.95	33.54
126	.50	5.6125	28.06	33.67
127	.75	5.6347	28.17	33.81
128	32.	5.6569	28.28	33.94
129	.25	5.6789	28.39	34.07
130	.50	5.7009	28.50	34.21
131	.75	5.7228	28.61	34.34
132	33.	5.7446	28.72	34.47
133	.25	5.7663	28.83	34.60
134	.50	5.7879	28.94	34.73
135	.75	5.8095	29.05	34.86
136	34.	5.8310	29.15	34.99
137	.25	5.8524	29.26	35.11
138	.50	5.8737	29.37	35.24
139	.75	5.8949	29.47	35.37
140	35.	5.9161	29.58	35.50
141	.25	5.9372	29.69	35.62
142	.50	5.9582	29.79	35.75
143	.75	5.9791	29.90	35.87
144	36.	6.	30.	36.
145	.25	6.0208	30.10	36.12
146	.50	6.0415	30.21	36.25
147	.75	6.0622	30.31	36.37
148	37.	6.0828	30.41	36.50
149	.25	6.1033	30.52	36.62
150	.50	6.1237	30.62	36.74

FIVE PLY.

No. of yarn to be twist'd.	No. of twisted yarn.	Sq. root of No. twisted yarn.	Square root multiplied by			No. of yarn to be twist'd.	No of twisted yarn.	Sq. root of No. twisted yarn.	Square root multiplied by	
			4	5	6				5	6
1	.2	.4472	1.79	2.24	2.68	76	15.2	3.8987	19.49	23.39
2	.4	.6325	2.53	3.16	3.79	77	.4	3.9243	19.62	23.55
3	.6	.7746	3.10	3.87	4.65	78	.6	3.9497	19.75	23.70
4	.8	.8944	3.58	4.47	5.37	79	.8	3.9749	19.87	23.85
5	1.	1.	4.	5.	6.	**80**	16.	4.	20.	24.
6	.2	1.0954	4.38	5.48	6.57	81	.2	4.0249	20.12	24.15
7	.4	1.1832	4.73	5.92	7.10	82	.4	4.0497	20.25	24.30
8	.6	1.2649	5.06	6.32	7.59	83	.6	4.0743	20.37	24.45
9	.8	1.3416	5.37	6.71	8.05	84	.8	4.0988	20.49	24.59
10	2.	1.4142	5.66	7.07	8.49	85	17.	4.1231	20.62	24.74
11	.2	1.4832	5.93	7.42	8.90	86	.2	4.1473	20.74	24.88
12	.4	1.5492	6.20	7.75	9.30	87	.4	4.1713	20.86	25.03
13	.6	1.6125	6.45	8.06	9.67	88	.6	4.1952	20.98	25.17
14	.8	1.6733	6.69	8.37	10.04	89	.8	4.2190	21.10	25.31
15	3.	1.7321	6.93	8.66	10.39	**90**	18.	4.2426	21.21	25.46
16	.2	1.7889	7.16	8.95	10.73	91	.2	4.2661	21.33	25.60
17	.4	1.8439	7.38	9.22	11.06	92	.4	4.2895	21.45	25.74
18	.6	1.8974	7.59	9.49	11.38	93	.6	4.3128	21.56	25.88
19	.8	1.9494	7.80	9.75	11.70	94	.8	4.3359	21.68	26.02
20	4.	2.	8.	10.	12.	95	19.	4.3589	21.79	26.15
21	.2	2.0494	8.20	10.25	12.30	96	.2	4.3818	21.91	26.29
22	.4	2.0976	8.39	10.49	12.59	97	.4	4.4045	22.02	26.43
23	.6	2.1448	8.58	10.72	12.87	98	.6	4.4272	22.14	26.56
24	.8	2.1909	8.76	10.95	13.15	99	.8	4.4497	22.25	26.70
25	5.	2.2361	8.94	11.18	13.42	**100**	20.	4.4721	22.36	26.83
26	.2	2.2804	9.12	11.40	13.68	101	.2	4.4944	22.47	26.97
27	.4	2.3238	9.30	11.62	13.94	102	.4	4.5166	22.58	27.10
28	.6	2.3664	9.47	11.83	14.20	103	.6	4.5387	22.69	27.23
29	.8	2.4083	9.63	12.04	14.45	104	.8	4.5607	22.80	27.36
30	6.	2.4495	9.80	12.25	14.70	105	21.	4.5826	22.91	27.50
31	.2	2.4900	9.96	12.45	14.94	106	.2	4.6043	23.02	27.63
32	.4	2.5298	10.12	12.65	15.18	107	.4	4.6260	23.13	27.76
33	.6	2.5690	10.28	12.85	15.41	108	.6	4.6476	23.24	27.89
34	.8	2.6077	10.43	13.04	15.65	109	.8	4.6690	23.35	28.01
35	7.	2.6458	10.58	13.23	15.87	**110**	22.	4.6904	23.45	28.14
36	.2	2.6833	10.73	13.42	16.10	111	.2	4.7117	23.56	28.27
37	.4	2.7203	10.88	13.60	16.32	112	.4	4.7329	23.66	28.40
38	.6	2.7568	11.03	13.78	16.54	113	.6	4.7539	23.77	28.52
39	.8	2.7928	11.17	13.96	16.76	114	.8	4.7749	23.87	28.65
40	8.	2.8284	11.31	14.14	16.97	115	23.	4.7958	23.98	28.77
41	.2	2.8636	11.45	14.32	17.18	116	.2	4.8166	24.08	28.90
42	.4	2.8983	11.59	14.49	17.39	117	.4	4.8374	24.19	29.02
43	.6	2.9326	11.73	14.66	17.60	118	.6	4.8580	24.29	29.15
44	.8	2.9665	11.87	14.83	17.80	119	.8	4.8785	24.39	29.27
45	9.	3.	12.	15.	18.	**120**	24.	4.8990	24.49	29.39
46	.2	3.0332	12.13	15.17	18.20	121	.2	4.9193	24.60	29.52
47	.4	3.0659	12.26	15.33	18.40	122	.4	4.9396	24.70	29.64
48	.6	3.0984	12.39	15.49	18.59	123	.6	4.9598	24.80	29.76
49	.8	3.1305	12.52	15.65	18.78	124	.8	4.9800	24.90	29.88
50	10.	3.1623	12.65	15.81	18.97	125	25.	5.	25.	30.
51	.2	3.1937	12.77	15.97	19.16	126	.2	5.0200	25.10	30.12
52	.4	3.2249	12.90	16.12	19.35	127	.4	5.0398	25.20	30.24
53	.6	3.2558	13.02	16.28	19.53	128	.6	5.0596	25.30	30.36
54	.8	3.2863	13.15	16.43	19.72	129	.8	5.0794	25.40	30.48
55	11.	3.3166	13.27	16.58	19.90	**130**	26.	5.0990	25.50	30.59
56	.2	3.3466	13.39	16.73	20.08	131	.2	5.1186	25.59	30.71
57	.4	3.3764	13.51	16.88	20.26	132	.4	5.1381	25.69	30.83
58	.6	3.4059	13.62	17.03	20.44	133	.6	5.1575	25.79	30.95
59	.8	3.4351	13.74	17.18	20.61	134	.8	5.1769	25.88	31.06
60	12.	3.4641	13.86	17.32	20.78	135	27.	5.1962	25.98	31.18
61	.2	3.4928	13.97	17.46	20.96	136	.2	5.2154	26.08	31.29
62	.4	3.5214	14.09	17.61	21.13	137	.4	5.2345	26.17	31.41
63	.6	3.5496	14.20	17.75	21.30	138	.6	5.2536	26.27	31.52
64	.8	3.5777	14.31	17.89	21.47	139	.8	5.2726	26.36	31.64
65	13.	3.6056	14.42	18.03	21.63	**140**	28.	5.2915	26.46	31.75
66	.2	3.6332	14.53	18.17	21.80	141	.2	5.3104	26.55	31.86
67	.4	3.6606	14.64	18.30	21.96	142	.4	5.3292	26.65	31.97
68	.6	3.6878	14.75	18.44	22.13	143	.6	5.3479	26.74	32.09
69	.8	3.7148	14.86	18.57	22.29	144	.8	5.3666	26.83	32.20
70	14.	3.7417	14.97	18.71	22.45	145	29.	5.3852	26.93	32.31
71	.2	3.7683	15.07	18.84	22.61	146	.2	5.4037	27.02	32.42
72	.4	3.7947	15.18	18.97	22.77	147	.4	5.4222	27.11	32.53
73	.6	3.8210	15.28	19.10	22.93	148	.6	5.4406	27.20	32.64
74	.8	3.8471	15.38	19.24	23.08	149	.8	5.4589	27.29	32.75
75	15.	3.8730	15.49	19.37	23.24	**150**	30.	5.4772	27.39	32.86

SIX PLY.

No. of yarn to be twist'd.	No. of twisted yarn.	Sq. root of No. twisted yarn.	Square root multiplied by		
			4	5	6
1	.17	.4082	1.63	2.04	2.45
2	.33	.5774	2.31	2.89	3.46
3	.50	.7071	2.83	3.54	4.24
4	.67	.8165	3.27	4.08	4.90
5	.83	.9129	3.65	4.56	5.48
6	1.	1.	4.	5.	6.
7	.17	1.0801	4.32	5.40	6.48
8	.33	1.1547	4.62	5.77	6.93
9	.50	1.2247	4.90	6.12	7.35
10	.67	1.2910	5.16	6.45	7.75
11	.83	1.3540	5.42	6.77	8.12
12	2.	1.4142	5.66	7.07	8.49
13	.17	1.4720	5.89	7.36	8.83
14	.33	1.5275	6.11	7.64	9.17
15	.50	1.5811	6.32	7.91	9.49
16	.67	1.6330	6.53	8.16	9.80
17	.83	1.6833	6.73	8.42	10.10
18	3.	1.7321	6.93	8.66	10.39
19	.17	1.7795	7.12	8.90	10.68
20	.33	1.8257	7.30	9.13	10.95
21	.50	1.8708	7.48	9.35	11.22
22	.67	1.9149	7.66	9.57	11.49
23	.83	1.9579	7.83	9.79	11.75
24	4.	2.	8.	10.	12.
25	.17	2.0412	8.16	10.21	12.25
26	.33	2.0817	8.33	10.41	12.49
27	.50	2.1213	8.49	10.61	12.73
28	.67	2.1602	8.64	10.80	12.96
29	.83	2.1985	8.79	10.99	13.19
30	5.	2.2361	8.94	11.18	13.42
31	.17	2.2730	9.09	11.37	13.64
32	.33	2.3094	9.24	11.55	13.86
33	.50	2.3452	9.38	11.73	14.07
34	.67	2.3805	9.52	11.90	14.28
35	.83	2.4152	9.66	12.08	14.49
36	6.	2.4495	9.80	12.25	14.70
37	.17	2.4833	9.93	12.42	14.90
38	.33	2.5166	10.07	12.58	15.10
39	.50	2.5495	10.20	12.75	15.30
40	.67	2.5820	10.53	12.91	15.49
41	.83	2.6141	10.46	13.07	15.68
42	7.	2.6458	10.58	13.23	15.87
43	.17	2.6771	10.71	13.39	16.06
44	.33	2.7080	10.33	13.54	16.25
45	.50	2.7386	10.95	13.69	16.43
46	.67	2.7689	11.08	13.84	16.61
47	.83	2.7988	11.20	13.99	16.79
48	8.	2.8284	11.31	14.14	16.97
49	.17	2.8577	11.43	14.29	17.15
50	.33	2.8868	11.55	14.43	17.32
51	.50	2.9155	11.66	14.58	17.49
52	.67	2.9439	11.78	14.72	17.66
53	.83	2.9721	11.89	14.86	17.83
54	9.	3.	12.	15.	18.
55	.17	3.0277	12.11	15.14	18.17
56	.33	3.0551	12.22	15.28	18.33
57	.50	3.0822	12.33	15.41	18.49
58	.67	3.1091	12.44	15.55	18.65
59	.83	3.1358	12.54	15.68	18.81
60	10.	3.1623	12.65	15.81	18.97
61	.17	3.1885	12.75	15.94	19.13
62	.33	3.2145	12.86	16.07	19.29
63	.50	3.2404	12.96	16.20	19.44
64	.67	3.2659	13.06	16.33	19.60
65	.83	3.2914	13.17	16.46	19.75
66	11.	3.3166	13.27	16.58	19.90
67	.17	3.3417	13.37	16.71	20.05
68	.33	3.3665	13.47	16.83	20.20
69	.50	3.3912	13.56	16.96	20.35
70	.67	3.4157	13.66	17.08	20.49
71	.83	3.4400	13.76	17.20	20.64
72	12.	3.4641	13.86	17.32	20.78
73	.17	3.4881	13.95	17.44	20.93
74	.33	3.5119	14.05	17.56	21.07
75	.50	3.5355	14.14	17.68	21.21
76	12.67	3.5590	17.80	21.35	
77	.83	3.5824	17.91	21.49	
78	13.	3.6056	18.03	21.63	
79	.17	3.6286	18.14	21.77	
80	.33	3.6515	18.26	21.91	
81	.50	3.6742	18.37	22.05	
82	.67	3.6969	18.48	22.18	
83	.83	3.7192	18.60	22.32	
84	14.	3.7417	18.71	22.45	
85	.17	3.7639	18.82	22.58	
86	.33	3.7859	18.93	22.72	
87	.50	3.8079	19.04	22.85	
88	.67	3.8297	19.15	22.98	
89	.83	3.8514	19.26	23.11	
90	15.	3.8730	19.36	23.24	
91	.17	3.8944	19.47	23.37	
92	.33	3.9158	19.58	23.49	
93	.50	3.9370	19.69	23.62	
94	.67	3.9582	19.79	23.75	
95	.83	3.9791	19.90	23.87	
96	16.	4.	20.	24.	
97	.17	4.0208	20.10	24.12	
98	.33	4.0415	20.21	24.25	
99	.50	4.0620	20.31	24.37	
100	.67	4.0825	20.41	24.49	
101	.83	4.1028	20.51	24.62	
102	17.	4.1231	20.62	24.74	
103	.17	4.1433	20.72	24.86	
104	.33	4.1633	20.82	24.98	
105	.50	4.1833	20.92	25.10	
106	.67	4.2032	21.02	25.22	
107	.83	4.2229	21.11	25.34	
108	18.	4.2426	21.21	25.46	
109	.17	4.2622	21.31	25.57	
110	.33	4.2817	21.41	25.69	
111	.50	4.3012	21.51	25.81	
112	.67	4.3205	21.60	25.92	
113	.83	4.3397	21.70	26.04	
114	19.	4.3589	21.79	26.15	
115	.17	4.3780	21.89	26.27	
116	.33	4.3970	21.98	26.38	
117	.50	4.4159	22.08	26.50	
118	.67	4.4347	22.17	26.61	
119	.83	4.4535	22.27	26.72	
120	20.	4.4721	22.36	26.83	
121	.17	4.4907	22.45	26.94	
122	.33	4.5092	22.55	27.06	
123	.50	4.5277	22.64	27.17	
124	.67	4.5461	22.73	27.28	
125	.83	4.5644	22.82	27.39	
126	21.	4.5826	22.91	27.50	
127	.17	4.6007	23.00	27.60	
128	.33	4.6188	23.09	27.71	
129	.50	4.6368	23.18	27.82	
130	.67	4.6547	23.27	27.93	
131	.83	4.6726	23.36	28.04	
132	22.	4.6904	23.45	28.14	
133	.17	4.7081	23.54	28.25	
134	.33	4.7258	23.63	28.35	
135	.50	4.7434	23.72	28.46	
136	.67	4.7610	23.80	28.57	
137	.83	4.7784	23.89	28.67	
138	23.	4.7958	23.98	28.77	
139	.17	4.8132	24.07	28.88	
140	.33	4.8305	24.15	28.98	
141	.50	4.8477	24.24	29.09	
142	.67	4.8648	24.32	29.19	
143	.83	4.8819	24.41	29.29	
144	24.	4.8990	24.49	29.39	
145	.17	4.9160	24.58	29.50	
146	.33	4.9329	24.66	29.60	
147	.50	4.9497	24.75	29.70	
148	.67	4.9666	24.83	29.80	
149	.83	4.9833	24.92	29.90	
150	25.	5.	25.	30.	

WEAVING.

Our general comments on the weave room will be found in our data relating to the Northrop loom, both in this book and in outside publications. The weave room covers so many possible combinations in machine and product, that there are few general statements that may be made. Looms endeavor to perform so many unmechanical operations, that they do not fall within the ordinary class of machine, and the shop trained mechanic or engineering expert would find "fixing" an impossible task, his varied experience in other lines being worthless in this special sphere. The weave room presents the most notable instance of piece payment in the cotton mill system, and also the chief instance of personal responsibility for defect in product.

The fact that the weaver must rely on the efforts of another laborer, to keep the machinery up to its best efficiency, also complicates the problem of management. American cotton mills are continually forced into additional complications by the requirements of more varied weaves, the curious insistence of style calling for continual changes in patterns. The Jacquard motion, the Dobby and various other attachments are getting more common, and the skill and experience of the operative must necessarily assume a higher plane, in conformity to new requirements.

We make no attempt to touch upon the various points involved in fancy weaves, as the limits of the present volume are too narrow. Much of the necessary education, and by far the better part, must come from actual experience. Reference to the problems introduced by automatic weaving will be found elsewhere.

RULES AND INFORMATION FOR WEAVERS.

For numbering yarns see pages 84-91.

To find the number of yards of cloth to the pound avoirdupois:

Multiply its width in inches by the weight in grains of a piece containing 1 square inch; divide 194.44 by the product and the quotient will be the number of yards to the pound. *Example:* Width of cloth, 30 inches; weight of 1 square inch, 1.5 grains. $\frac{194.44}{30\times1.5}=4.32$ yards per pound.

To find the average number of yarn required to produce cloth of any desired weight, width, and pick:

Add together the number of picks per inch of warp and filling; multiply their sum by the yards of cloth per pound, and this product by the width in inches; divide by 840, and the quotient will be the average number of yarn required. For any increase in weight by sizing, proportional allowance must be made in the yarn.

N. B.—As the filling is taken up in crossing the warp, and the amount varies in different goods, this rule is not exact, but will approximate near enough to furnish a basis for practical purposes.

Weight of a square yard of cloth when the weight of a square inch is given:

Weight of sq. in. in grains.	1	2	3	4	5	6	7
Weight of sq. yd. in lbs.	.1851	.3703	.5554	.7406	.9257	1.1109	1.2961

To find the size of warp of filling in any piece of goods:

Take 8 or more threads of any known number, say 2 feet long, and tie the ends together; this makes a link, through which draw the same number of threads of the same length of the unknown number, and twist the two links thus made as you would twist a chain. A keen eye will detect any difference in the size of the two links. By adding to or taking from either link, they can be varied in size in proportion to the number of threads used, and brought to nearly equal each other. When as nearly as possible alike, the unknown number can be approximately determined by the proportionate number of strands in each link. Thus, if 28 is the known number, and if 7 strands of the unknown make an equal size link of 8 strands of the known, the number of the unknown will be $\frac{7}{8}$ of 28=24.5.

Cotton cloth is sold on a basis of a certain number of yards to the pound, with a certain number of picks or threads per inch in warp and filling.

Standard print cloths weigh seven yards to the pound, have 64 picks of warp and filling to the inch, and are called 64×64—seven-yard goods.

Loom reeds are numbered by the number of dents or splits to the inch. The number of threads in a warp divided by the number of the reed multiplied by the width in inches, will give the number of threads in a dent.

Linens take their technical fineness from the number of hundred dents or splits in a loom reed thirty-seven inches wide. There are two threads to each dent. The following table, adapted from Barlow's "History of Weaving," gives the number of threads to the inch for each "count" of linen goods:

Hundreds.	Threads per inch.	Hundreds.	Threads per inch.	Hundreds.	Threads per inch.	Hundreds.	Threads per inch.
5 00	27.03	12 00	64.86	19 00	102.7	26 00	140.5
6 00	32.43	13 00	70.27	20 00	108.1	27 00	145.9
7 00	37.84	14 00	75.68	21 00	113.5	28 00	151.4
8 00	43.24	15 00	81.08	22 00	118.9	29 00	156.8
9 00	48.65	16 00	86.49	23 00	124.3	30 00	162.2
10 00	54.05	17 00	91.89	24 00	129.7	31 00	167.6
11 00	59.46	18 00	97.30	25 00	135.1	32 00	173.0

Weight of warp or filling in one square yard:

The tables on pages 102-105 give the weight in decimals of a pound of the quantity of common warp and weft or filling in one square yard of cloth for any number of yarn, from five to one hundred, and for any number of picks per inch from twenty to one hundred and eighty. Multiply the weight given in the tables by .525 for woolen, 1.5 for worsted, 2.8 for linen and .525 for silk, if the number of the silk represents the number of hundred yards per ounce.

Both warp and filling take up in weaving, by passing over and under alternate threads; therefore, one yard of warp or filling will fall a percentage short of making a yard of cloth. This percentage varies with each different size of yarn and number of picks per inch, and for other reasons; consequently, the tables have been made, giving the weights of straight yarn, to which must be added the take-up or shrinkage, to obtain the precise weight of a yard of cloth. It may be safe to say that from seven to eight per cent. is an average shrinkage on cotton goods. On some woolen cloths, the finishing processes reduce the weight so that the calculated weights are as near as may be to the weight of the finished goods.

Yarn is commonly numbered before it is slashed or sized, and in estimating the weight of finished cloth, the quantity of sizing added to the warp must be known.

Production in yards of a loom running constantly for ten hours:

The tables on pages 106—107 give the number of yards of cloth which can be woven per loom in one day of ten hours, if the loom runs constantly. If the quantity given in the tables is exceeded in the production of any loom, it shows that an error has been made in estimating the number of picks per inch or in the speed of the loom. Of course, the same errors might account for a falling *short* of the quantities in the table; but as no loom runs constantly, the difference between the actual production and the possible production, represents the quantity that might be woven during the time that the loom is stopped. The percentage of time of stoppage of a loom can be ascertained by dividing this difference by the possible production.

The following tables were prepared by Mr. Richards of the Maginnis Cotton Mills in New Orleans.

No. of yarn.	Picks per inch.									
	20	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**
5	.171	.180	.189	.197	.206	.214	.223	.231	.240	.249
6	.143	.150	.157	.164	.171	.179	.186	.193	.200	.207
7	.122	.129	.135	.141	.147	.153	.159	.165	.171	.178
8	.107	.112	.118	.123	.129	.134	.139	.145	.150	.155
9	.095	.100	.105	.110	.114	.119	.124	.129	.133	.138
10	.086	.090	.094	.099	.103	.107	.111	.116	.120	.124
11	.078	.082	.086	.090	.094	.097	.101	.105	.109	.113
12	.071	.075	.079	.082	.086	.089	.093	.096	.100	.104
13	.066	.069	.073	.076	.079	.082	.086	.089	.092	.096
14	.061	.064	.067	.070	.073	.077	.080	.083	.086	.089
15	.057	.060	.063	.066	.069	.071	.074	.077	.080	.083
16	.054	.056	.059	.062	.064	.067	.070	.072	.075	.078
17	.050	.053	.055	.058	.060	.063	.066	.068	.071	.073
18	.048	.050	.052	.055	.057	.060	.062	.064	.067	.069
19	.045	.047	.050	.052	.054	.056	.059	.061	.063	.065
20	.043	.045	.047	.049	.051	.054	.056	.058	.060	.062
21	.041	.043	.045	.047	.049	.051	.053	.055	.057	.059
22	.039	.041	.043	.045	.047	.049	.051	.053	.055	.056
23	.037	.039	.041	.043	.045	.047	.048	.050	.052	.054
24	.036	.037	.039	.041	.043	.045	.046	.048	.050	.052
25	.034	.036	.038	.039	.041	.043	.045	.046	.048	.050
26	.033	.035	.036	.038	.040	.041	.043	.045	.046	.048
27	.032	.033	.035	.037	.038	.040	.041	.043	.044	.046
28	.031	.032	.034	.035	.037	.038	.040	.041	.043	.044
29	.030	.031	.032	.034	.035	.037	.038	.040	.041	.043
30	.029	.030	.031	.033	.034	.036	.037	.039	.040	.041
31	.028	.029	.030	.032	.033	.035	.036	.037	.039	.040
32	.027	.028	.029	.031	.032	.033	.035	.036	.037	.039
33	.026	.027	.029	.030	.031	.032	.034	.035	.036	.038
34	.025	.026	.028	.029	.030	.032	.033	.034	.035	.037
35	.024	.026	.027	.028	.029	.031	.032	.033	.034	.036
36	.024	.025	.026	.027	.029	.030	.031	.032	.033	.035
37	.023	.024	.025	.027	.028	.029	.030	.031	.032	.034
38	.023	.024	.025	.026	.027	.028	.029	.030	.032	.033
39	.022	.023	.024	.025	.026	.027	.029	.030	.031	.032
40	.021	.022	.024	.025	.026	.027	.028	.029	.030	.031
	30	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**
5	.257	.266	.274	.283	.291	.300	.309	.317	.326	.334
6	.214	.221	.229	.236	.243	.250	.257	.264	.271	.279
7	.184	.190	.196	.202	.208	.214	.220	.227	.233	.239
8	.161	.166	.171	.177	.182	.187	.193	.197	.204	.209
9	.143	.148	.152	.157	.162	.167	.171	.176	.181	.186
10	.129	.133	.137	.141	.146	.150	.154	.159	.163	.167
11	.117	.121	.125	.129	.132	.136	.140	.144	.148	.152
12	.107	.111	.114	.118	.121	.125	.129	.132	.136	.139
13	.099	.102	.105	.109	.112	.115	.119	.122	.125	.129
14	.092	.095	.098	.101	.104	.107	.110	.113	.116	.119
15	.086	.089	.091	.094	.097	.100	.103	.106	.109	.111
16	.080	.083	.086	.088	.091	.094	.096	.099	.102	.104
17	.076	.078	.081	.083	.086	.088	.091	.093	.096	.098
18	.071	.074	.076	.079	.081	.083	.086	.088	.090	.093
19	.068	.070	.072	.074	.077	.079	.081	.083	.086	.088
20	.064	.066	.069	.071	.073	.075	.077	.079	.081	.084
21	.061	.063	.065	.067	.069	.071	.073	.076	.078	.080
22	.058	.060	.062	.064	.066	.068	.070	.072	.074	.076
23	.056	.058	.060	.061	.063	.065	.067	.069	.071	.073
24	.054	.055	.057	.059	.061	.062	.064	.066	.068	.070
25	.051	.053	.055	.057	.058	.060	.062	.063	.065	.067
26	.049	.051	.053	.054	.056	.058	.059	.061	.063	.064
27	.048	.049	.051	.052	.054	.056	.057	.059	.060	.062
28	.046	.047	.049	.051	.052	.054	.055	.057	.058	.060
29	.044	.046	.047	.049	.050	.052	.053	.055	.056	.058
30	.043	.044	.046	.047	.049	.050	.051	.053	.054	.056
31	.041	.043	.044	.043	.047	.048	.050	.051	.052	.054
32	.040	.042	.043	.044	.046	.047	.048	.050	.051	.052
33	.039	.040	.042	.043	.044	.045	.047	.048	.049	.051
34	.038	.039	.040	.042	.043	.044	.045	.047	.048	.049
35	.037	.038	.039	.040	.042	.043	.044	.045	.046	.048
36	.036	.037	.038	.039	.040	.042	.043	.044	.045	.046
37	.035	.036	.037	.038	.039	.041	.042	.043	.044	.045
38	.034	.035	.036	.037	.038	.039	.041	.042	.043	.044
39	.033	.034	.035	.036	.037	.038	.040	.041	.042	.043
40	.032	.033	.034	.035	.036	.037	.039	.040	.041	.042

No. of yarn	Picks per inch.									
	40	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**
10	.171	.176	.180	.184	.189	.193	.197	.201	.206	.210
11	.156	.160	.164	.168	.171	.175	.179	.183	.187	.191
12	.143	.146	.150	.154	.157	.161	.164	.168	.171	.175
13	.132	.135	.138	.142	.145	.148	.152	.155	.158	.162
14	.122	.126	.129	.132	.135	.138	.141	.144	.147	.150
15	.114	.117	.120	.123	.126	.129	.131	.134	.137	.140
16	.107	.110	.112	.115	.118	.121	.123	.126	.129	.131
17	.101	.103	.106	.108	.111	.113	.116	.118	.121	.124
18	.095	.098	.100	.102	.105	.107	.110	.112	.114	.117
19	.090	.092	.095	.097	.099	.102	.104	.106	.108	.110
20	.086	.088	.090	.092	.094	.096	.099	.101	.103	.105
21	.082	.084	.086	.088	.090	.092	.094	.096	.098	.100
22	.078	.080	.082	.084	.086	.088	.090	.092	.094	.095
23	.075	.076	.078	.080	.082	.084	.086	.088	.089	.091
24	.071	.073	.075	.077	.079	.080	.082	.084	.086	.087
25	.069	.070	.072	.074	.075	.077	.079	.081	.082	.084
26	.066	.068	.069	.071	.073	.074	.076	.077	.079	.081
27	.063	.065	.067	.068	.070	.071	.073	.075	.076	.078
28	.061	.063	.064	.066	.067	.069	.070	.072	.073	.075
29	.059	.061	.062	.064	.065	.067	.068	.069	.071	.072
30	.057	.059	.060	.061	.063	.064	.066	.067	.069	.070
31	.055	.057	.058	.059	.061	.062	.064	.065	.066	.068
32	.054	.055	.056	.058	.059	.060	.062	.063	.064	.066
33	.052	.053	.055	.056	.057	.058	.060	.061	.062	.064
34	.050	.052	.053	.054	.055	.057	.058	.059	.061	.062
35	.049	.050	.051	.053	.054	.055	.056	.058	.059	.060
36	.048	.049	.050	.051	.052	.054	.055	.056	.057	.058
37	.046	.047	.049	.050	.051	.052	.053	.054	.056	.057
38	.045	.046	.047	.048	.050	.051	.052	.053	.054	.055
39	.044	.045	.046	.047	.048	.049	.051	.052	.053	.054
40	.043	.044	.045	.046	.047	.048	.049	.050	.051	.052
41	.042	.043	.044	.045	.046	.047	.048	.049	.050	.051
42	.041	.042	.043	.044	.045	.046	.047	.048	.049	.050
43	.040	.041	.042	.043	.044	.045	.046	.047	.048	.049
44	.039	.040	.041	.042	.043	.044	.045	.046	.047	.048
45	.038	.039	.040	.041	.042	.043	.044	.045	.046	.047
	50	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**
10	.214	.219	.223	.227	.231	.236	.240	.244	.249	.253
11	.195	.199	.203	.206	.210	.214	.218	.222	.226	.230
12	.179	.182	.186	.189	.193	.196	.200	.204	.207	.211
13	.165	.168	.171	.175	.178	.181	.185	.188	.191	.195
14	.153	.156	.159	.162	.165	.168	.171	.174	.178	.181
15	.143	.146	.149	.151	.154	.157	.160	.163	.166	.169
16	.134	.137	.139	.142	.145	.147	.150	.153	.155	.158
17	.126	.129	.131	.134	.136	.139	.141	.144	.146	.149
18	.119	.121	.124	.126	.129	.131	.133	.136	.138	.140
19	.113	.115	.117	.120	.122	.124	.126	.129	.131	.133
20	.107	.109	.111	.114	.116	.118	.120	.122	.124	.126
21	.102	.104	.106	.108	.110	.112	.114	.116	.118	.120
22	.097	.099	.101	.103	.105	.107	.109	.111	.113	.115
23	.093	.095	.097	.099	.101	.102	.104	.106	.108	.110
24	.089	.091	.093	.095	.096	.098	.100	.102	.104	.105
25	.086	.087	.089	.091	.093	.094	.096	.098	.099	.101
26	.082	.084	.086	.087	.089	.091	.092	.094	.096	.097
27	.079	.081	.083	.084	.086	.087	.089	.090	.092	.094
28	.077	.078	.080	.081	.083	.084	.086	.087	.089	.090
29	.074	.075	.077	.078	.080	.081	.083	.084	.086	.087
30	.071	.073	.074	.076	.077	.079	.080	.081	.083	.084
31	.069	.071	.072	.073	.075	.076	.077	.079	.080	.082
32	.067	.068	.070	.071	.072	.074	.075	.076	.078	.079
33	.065	.066	.068	.069	.070	.071	.073	.074	.075	.077
34	.063	.064	.066	.067	.068	.069	.071	.072	.073	.074
35	.061	.062	.064	.065	.066	.067	.069	.070	.071	.072
36	.060	.061	.062	.063	.064	.065	.067	.068	.069	.070
37	.058	.059	.060	.061	.063	.064	.065	.066	.067	.068
38	.056	.058	.059	.060	.061	.062	.063	.064	.065	.067
39	.055	.056	.057	.058	.059	.060	.062	.063	.064	.065
40	.054	.055	.056	.057	.058	.059	.060	.061	.062	.063
41	.052	.053	.054	.055	.056	.057	.059	.060	.061	062
42	.051	.052	.053	.054	.055	.056	.057	.058	.059	.060
43	.050	.051	.052	.053	.054	.055	.056	.057	.058	.059
44	.049	.050	.051	.052	.053	.054	.055	.056	.056	.057
45	.048	.049	.050	.050	.051	.052	.053	.054	.055	.056

No. of yarn.	Picks per inch.										
	60	**62**	**64**	**66**	**68**	**70**	**72**	**74**	**76**	**78**	**80**
15	.171	.177	.183	.189	.194	.200	.206	.211	.217	.223	.229
16	.161	.166	171	.177	.182	.187	.193	.197	.204	.209	.214
17	.151	.156	.161	.166	171	.176	.182	.187	.192	.197	.202
18	.143	.148	.152	.157	.162	.167	.171	.176	.181	.186	.190
19	.135	.140	.144	.149	.153	.158	.162	.167	.171	.176	.180
20	.129	.133	.137	.141	.146	.150	.154	.159	.163	.167	.171
21	.122	.127	.131	.135	.139	.143	.147	.151	.155	.159	.163
22	117	.121	.125	.129	.132	.136	.140	.144	.148	.152	.156
23	.112	.116	.119	.123	.127	.130	.134	.138	.142	.145	.149
24	.107	.111	.114	.118	.121	.125	.129	.132	.136	.139	.143
25	.103	.106	.110	.113	.117	.120	.123	.127	.130	.134	.137
26	.099	.102	.105	.109	.112	.115	.119	.122	.125	.129	.132
27	.095	.098	.102	.105	.108	.111	.114	.117	.121	.124	.127
28	.092	.095	.098	.101	.104	.107	.110	.113	.116	.119	.122
29	089	.092	.095	.098	.100	.103	.106	.109	.112	.115	.118
30	.086	.089	.091	.094	.097	.100	.103	.106	.109	.111	.114
31	083	.086	.088	.091	.094	.097	.100	.102	.105	.108	.111
32	.080	.083	.086	.088	.091	.094	.096	.099	.102	.104	.107
33	.078	.081	.083	.086	.088	.091	.094	.096	.099	.101	.104
34	.076	.078	.081	.083	.086	.088	.091	.093	.096	.098	.101
35	.073	.076	.078	.081	.083	.086	.088	.091	.093	.096	.098
36	071	.074	.076	.079	.081	.083	.086	.088	.090	.093	.095
37	.069	.072	.074	.076	.079	.081	.083	.086	.088	.090	.093
38	.068	.070	.072	074	.077	.079	.081	.083	.086	.088	.090
39	.066	.068	.070	.073	.075	.077	.079	.081	.084	.086	.088
40	.064	.066	.069	.071	.073	.075	.077	.079	.081	.084	.086
41	.063	.065	.067	.069	.071	.073	.075	.077	.079	.082	.084
42	.061	.063	.065	.067	.069	.071	.073	.076	.078	.080	.082
43	.060	.062	.064	.066	.068	.070	.072	.074	.076	.078	.080
44	.058	.060	.062	.064	.066	.068	.070	.072	.074	.076	.078
45	.057	.059	.061	063	.065	.067	.069	.070	.072	.074	.076
46	.056	.058	.060	.061	.063	.065	.067	.069	.071	.073	.075
47	.055	.057	.058	.060	.062	.064	.066	.067	.069	.071	.073
48	.054	.055	.057	059	.061	.062	.064	.066	.068	.070	.071
49	.052	.054	.056	.058	.059	.061	.063	.065	.066	.068	.070
50	.051	.053	.055	.057	.058	.060	.062	.063	.065	.067	.069
	80	**82**	**84**	**86**	**88**	**90**	**92**	**94**	**96**	**98**	**100**
20	.171	.176	.180	.184	.189	.193	.197	.201	.206	.210	.214
21	.163	.167	.171	.176	.180	.184	.188	.192	.196	.200	.204
22	.156	.160	.164	.168	.171	175	.179	.183	.187	.191	.195
23	.149	.153	.157	.160	.164	.168	.171	.175	.179	.183	.186
24	.143	.146	.150	.154	.157	.161	.164	.168	.171	.175	.179
25	137	.141	.144	.147	.151	.154	.158	.161	.165	.168	.171
26	.132	.135	.138	.142	.145	.148	.152	.155	.158	.162	.165
27	.127	.130	.133	.137	.140	.143	.146	.149	.152	.156	.159
28	122	.126	.129	.132	.135	.138	.141	.144	.147	.150	.153
29	.118	.121	.124	.127	.130	.133	.136	.139	.142	.145	.148
30	.114	.117	.120	.123	.126	.129	.131	.134	.137	.140	.143
31	.111	.113	.116	.119	.122	.124	.127	.130	.133	.135	.138
32	.107	.110	.112	.115	.118	.121	.123	.126	.129	.131	.134
33	.104	.107	.109	.112	.114	.117	.119	.122	.125	.127	.130
34	.101	.103	.106	.108	.111	.113	.116	.118	.121	.124	.126
35	.098	.100	.103	.105	.108	.110	.113	.115	.118	.120	.122
36	.095	.098	.100	.102	.105	.107	.110	.112	.114	.117	.119
37	.093	.095	.097	.100	.102	.104	.107	.109	.111	114	.116
38	.090	.092	.095	.097	.099	.102	.104	.106	.108	.110	.113
39	.088	.090	.092	.095	.097	.099	.101	.103	.105	.107	.110
40	.086	.088	.090	.092	.094	.096	.099	.101	.103	.105	107
41	.084	.086	.088	.090	.092	.094	.096	.098	.100	.102	105
42	.082	.084	.086	.088	.090	.092	.094	.096	098	.100	.102
43	.080	.082	.084	.086	.088	.090	.092	.094	.096	.098	10(
44	.078	.080	.082	.084	.086	.088	.090	.092	.094	.095	.097
45	.076	.078	.080	.082	.084	.086	.088	.090	.091	.093	.095
46	.075	.076	.078	.080	.082	.084	.086	.088	.089	.091	.093
47	.073	.075	.077	.078	.080	.082	.084	.086	.088	.089	.091
48	.071	.073	.075	.077	.079	.080	.082	.084	.086	.087	.089
49	.070	.072	.073	.075	.077	.079	.080	.082	.084	.086	.087
50	.069	.070	.072	.074	.075	.077	.079	.081	.082	.084	.086
51	067	.069	.071	.072	.074	.076	.077	.079	.081	.082	.084
52	.066	.068	.069	.071	.073	.074	.076	.077	.079	.081	.082
53	.065	.066	.068	.070	.071	.073	.074	.076	.078	079	.081
54	.063	.065	.067	068	.070	.071	.073	.075	.076	.078	.079
55	.062	.064	.065	.067	.069	.070	.072	.073	.075	.076	.078

No. of yarn.	Picks per inch.										
	100	**102**	**104**	**106**	**108**	**110**	**112**	**114**	**116**	**118**	**120**
30	.143	.146	.149	.151	.154	.157	.160	.163	.166	.169	.171
31	.138	.141	.144	.147	.149	.152	.155	.158	.160	.163	.166
32	.134	.137	.139	.142	.145	.147	.150	.153	.155	.158	.161
33	.130	.133	.135	.138	.140	.143	.145	.148	.151	.153	.156
34	.126	.129	.131	.134	.136	.139	.141	.144	.146	.149	.151
35	.122	.125	.127	.130	.132	.135	.137	.140	.142	.144	.147
36	.119	.121	.124	.126	.129	.131	.133	.136	.138	.140	.143
37	.116	.118	.120	.123	.125	.127	.130	.132	.134	.137	.139
38	.113	.115	.117	.120	.122	.124	.126	.129	.131	.133	.135
39	.110	.112	.114	.116	.119	.121	.123	.125	.127	.130	.132
40	.107	.109	.111	.114	.116	.118	.120	.122	.124	.126	.129
42	.102	.104	.106	.108	.110	.112	.114	.116	.118	.120	.122
44	.097	.099	.101	.103	.105	.107	.109	.111	.113	.115	.117
46	.093	.095	.097	.099	.101	.102	.104	.106	.108	.110	.112
48	.089	.091	.093	.095	.096	.098	.100	.102	.104	.105	.107
50	.086	.087	.089	.091	.093	.094	.096	.098	.099	.101	.103
52	.082	.084	.086	.087	.089	.091	.092	.094	.096	.097	.099
54	.079	.081	.083	.084	.086	.087	.089	.090	.092	.094	.095
56	.077	.078	.080	.081	.083	.084	.086	.087	.089	.090	.092
58	.074	.075	.077	.078	.080	.081	.083	.084	.086	.087	.089
60	.071	.073	.074	.076	.077	.079	.080	.081	.083	.084	.086
62	.069	.071	.072	.073	.075	.076	.077	.079	.080	.082	.083
64	.067	.068	.070	.071	.072	.074	.075	.076	.078	.079	.080
66	.065	.066	.068	.069	.070	.071	.073	.074	.075	.077	.078
68	.063	.064	.066	.067	.068	.069	.071	.072	.073	.074	.076
70	.061	.062	.064	.065	.066	.067	.069	.070	.071	.072	.073
	120	**122**	**124**	**126**	**128**	**130**	**132**	**134**	**136**	**138**	**140**
40	.129	.131	.133	.135	.137	.139	.141	.144	.146	.148	.150
42	.122	.124	.127	.129	.131	.133	.135	.137	.139	.141	.143
44	.117	.119	.121	.123	.125	.127	.129	.131	.132	.134	.136
46	.112	.114	.116	.117	.119	.121	.123	.125	.127	.129	.130
48	.107	.109	.111	.112	.114	.116	.118	.120	.121	.123	.125
50	.103	.105	.106	.108	.110	.111	.113	.115	.117	.118	.120
52	.099	.101	.102	.104	.105	.107	.109	.110	.112	.114	.115
54	.095	.097	.098	.100	.102	.103	.105	.106	.108	.109	.111
56	.092	.093	.095	.096	.098	.099	.101	.103	.104	.106	.107
58	.089	.090	.092	.093	.095	.096	.098	.099	.100	.102	.103
60	.086	.087	.089	.090	.091	.093	.094	.096	.097	.099	.100
62	.083	.084	.086	.087	.088	.090	.091	.093	.094	.095	.097
64	.080	.082	.083	.084	.086	.087	.088	.090	.091	.092	.094
66	.078	.079	.081	.082	.083	.084	.086	.087	.088	.090	.091
68	.076	.077	.078	.079	.081	.082	.083	.084	.086	.087	.088
70	.073	.075	.076	.077	.078	.080	.081	.082	.083	.084	.086
72	.071	.073	.074	.075	.076	.077	.079	.080	.081	.082	.083
74	.069	.071	.072	.073	.074	.075	.076	.078	.079	.080	.081
76	.068	.069	.070	.071	.072	.073	.074	.076	.077	.078	.079
78	.066	.067	.068	.069	.070	.071	.073	.074	.075	.076	.077
80	.064	.065	.066	.067	.069	.070	.071	.072	.073	.074	.075
	140	**142**	**144**	**146**	**148**	**150**	**152**	**154**	**156**	**158**	**160**
50	.120	.122	.123	.125	.127	.129	.130	.132	.134	.135	.137
52	.115	.117	.119	.120	.122	.124	.125	.127	.129	.130	.132
54	.111	.113	.114	.116	.117	.119	.121	.122	.124	.125	.127
56	.107	.109	.110	.112	.113	.115	.116	.118	.119	.121	.122
58	.103	.105	.106	.108	.109	.111	.112	.114	.115	.117	.118
60	.100	.101	.103	.104	.106	.107	.109	.110	.111	.113	.114
65	.092	.094	.095	.096	.098	.099	.100	.102	.103	.104	.105
70	.086	.087	.088	.089	.091	.092	.093	.094	.096	.097	.098
75	.080	.081	.082	.083	.085	.086	.087	.088	.089	.090	.092
80	.075	.076	.077	.078	.079	.080	.081	.083	.084	.085	.086
85	.071	.072	.073	.074	.075	.076	.077	.078	.079	.080	.081
	160	**162**	**164**	**166**	**168**	**170**	**172**	**174**	**176**	**178**	**180**
60	.114	.116	.117	.119	.120	.121	.123	.124	.126	.127	.129
65	.105	.106	.108	.109	.111	.112	.113	.115	.116	.117	.119
70	.098	.099	.100	.102	.103	.104	.105	.107	.108	.109	.110
75	.092	.093	.094	.095	.096	.097	.098	.099	.101	.102	.103
80	.086	.087	.088	.089	.090	.091	.092	.093	.094	.095	.096
85	.081	.082	.083	.084	.085	.086	.087	.088	.089	.090	.091
90	.076	.077	.078	.079	.080	.081	.082	.083	.084	.085	.086
95	.072	.073	.074	.075	.076	.076	.077	.078	.079	.080	.081
100	.069	.070	.070	.071	.072	.073	.074	.075	.075	.076	.077

Picks per inch	Picks per minute.										
	100	**105**	**110**	**115**	**120**	**125**	**130**	**135**	**140**	**145**	**150**
20	83.3	87.5	91.7	95.8	100.0	104.2	108.3	112.5	116.7	120.8	125.0
22	75.8	79.5	83.3	87.1	90.9	94 7	98.5	102.3	106.1	109.8	113.6
24	69.4	72.9	76.4	79.9	83.3	86.8	90.3	93.7	97.2	100.7	104.2
26	64.1	67.3	70.5	73.7	76.9	80.1	83.3	86.5	89.7	92.9	96.2
28	59.5	62.5	65.5	68.5	71.4	74.4	77.4	80.4	83.3	86.3	89.3
30	55.6	58.3	61.1	63.9	66.7	69.4	72.2	75.0	77.8	80.6	83.3
32	52.1	54.7	57.3	59.9	62.5	65.1	67.7	70.3	72.9	75.5	78.1
34	49.0	51.5	53.9	56.4	58.8	61.3	63.7	66.2	68.6	71.1	73.5
36	46.3	48.6	50.9	53.2	55.6	57.9	60.2	62.5	64.8	67.1	69.4
38	43.9	46.1	48.2	50.4	52.6	54 8	57.0	59.2	61.4	63.6	65.8
40	41.7	43.7	45.8	47.9	50.0	52.1	54.2	56.3	58.3	60.4	62.5
42	39.7	41.7	43.7	45.6	47.6	49.6	51.6	53.6	55.6	57.5	59.5
44	37.9	39.8	41.7	43.6	45.5	47.3	49.2	51.1	53.0	54.9	56.8
46	36.2	38.0	39.9	41.7	43.5	45.3	47.1	48.9	50.7	52.5	54.3
48	34.7	36.5	38.2	39.9	41.7	43.4	45.1	46.9	48.6	50.3	52.1
50	33 3	35.0	36.7	38.3	40.0	41 7	43.3	45.0	46.7	48.3	50.0
52	32 1	33.7	35.3	36.9	38.5	40.1	41.7	43.3	44.9	46.5	48.1
54	30.9	32.4	34.0	35.5	37.0	38.6	40.1	41.7	43.2	44.8	46.3
56	29.8	31.3	32.7	34.2	35.7	37.2	38.7	40.2	41.7	43.2	44.6
58	28.7	30.2	31.6	33.0	34.5	35.9	37.4	38.8	40.2	41.7	43.1
60	27.8	29.2	30.6	31.9	33.3	34.7	36.1	37.5	38.9	40.3	41.7
62	26.9	28.2	29.6	30.9	32.3	33.6	34.9	36.3	37.6	39.0	40.3
64	26.0	27.3	28.6	29.9	31.3	32.6	33.9	35.2	36.5	37.8	39.1
66	25.3	26.5	27.8	29.0	30.3	31.6	32.8	34.1	35.4	36.6	37.9
68	24.5	25.7	27.0	28.2	29.4	30.6	31.9	33.1	34.3	35.5	36.8
70	23.8	25.0	26.2	27.4	28.6	29.8	31.0	32.1	33.3	34.5	35.7
72	23.1	24.3	25.5	26.6	27.8	28.9	30.1	31.3	32.4	33.6	34.7
74	22.5	23.6	24.8	25.9	27.0	28.2	29.3	30.4	31.5	32.7	33.8
76	21.9	23.0	24.1	25.2	26.3	27.4	28.5	29.6	30.7	31.8	32.9
78	21.4	22.4	23.5	24.6	25.6	26.7	27.8	28.8	29.9	31.0	32.1
80	20.8	21.9	22.9	24.0	25 0	26.0	27.1	28.1	29.2	30.2	31.3
82	20.3	21.3	22.4	23.4	24.4	25.4	26.4	27.4	28.5	29.5	30.5
84	19.8	20.8	21.8	22.8	23.8	24.8	25.8	26.8	27.8	28.8	29.8
86	19.4	20.3	21.3	22.3	23.3	24.2	25.2	26.2	27.1	28.1	29.1
88	18.9	19.9	20.8	21.8	22.7	23.7	24.6	25.6	26.5	27.5	28.4
90	18.5	19.4	20.4	21.3	22.2	23.1	24.1	25.0	25.9	26.9	27.8
92	18.1	19.0	19.9	20.8	21.7	22.6	23.6	24.5	25.4	26.3	27.2
94	17.7	18.6	19.5	20.4	21.3	22.2	23.0	23.9	24.8	25 7	26.6
96	17.4	18.2	19.1	20.0	20.8	21.7	22.6	23.4	24.3	25.2	26.0
98	17.0	17.9	18.7	19.6	20.4	21 3	22.1	23.0	23.8	24.7	25.5
100	16.7	17.5	18.3	19.2	20.0	20.8	21.7	22.5	23.3	24.2	25.0
102	16.3	17.2	18.0	18.8	19.6	20.4	21.2	22.1	22.9	23.7	24.5
104	16.0	16.8	17.6	18.4	19 2	20.0	20.8	21.6	22.4	23.2	24.0
106	15.7	16.5	17.3	18.1	18.9	19.7	20.4	21.2	22.0	22.8	23.6
108	15.4	16.2	17.0	17.7	18.5	19.3	20.1	20.8	21.6	22.4	23.1
110	15.2	15.9	16.7	17.4	18.2	18.9	19.7	20.5	21.2	22.0	22.7
112	14.9	15.6	16.4	17.1	17.9	18.6	19.3	20.1	20.8	21.6	22.3
114	14.6	15.4	16.1	16.8	17.5	18.3	19.0	19.7	20.5	21.2	21.9
116	14.4	15.1	15.8	16.5	17.2	18.0	18.7	19.4	20.1	20.8	21.6
118	14.1	14.8	15.5	16.2	16.9	17.7	18.4	19.1	19.8	20.5	21.2
120	13.9	14.6	15.3	16.0	16.7	17.4	18.1	18.7	19.4	20.1	20.8
122	13.7	14.3	15.0	15.7	16.4	17.1	17.8	18.4	19.1	19.8	20.4
124	13.4	14.1	14.8	15.5	16.1	16.8	17.5	18.1	18.8	19.5	20.1
126	13.2	13.9	14.6	15.2	15.9	16.5	17.2	17.9	18.5	19.2	19.8
128	13.0	13.7	14.3	15.0	15.6	16.3	16.9	17.6	18.2	18.9	19.5
130	12.8	13.5	14.1	14.7	15.4	16.0	16.7	17.3	17.9	18.6	19.2
134	12.4	13.1	13.7	14.3	14.9	15.5	16.2	16.8	17.4	18.0	18.7
136	12.3	12.9	13.5	14.1	14 7	15.3	15.9	16.5	17.2	17.8	18.4
140	11.9	12.5	13.1	13.7	14.3	14 9	15.5	16.1	16.7	17.3	17.9
144	11.6	12.2	12.7	13.3	13.9	14.5	15.0	15.6	16.2	16.8	17.4
146	11.4	12.0	12.6	13.1	13 7	14.3	14.8	15.4	16.0	16.6	17.1
150	11.1	11.7	12.2	12.8	13.3	13.9	14.4	15.0	15.6	16.1	16.7
154	10.8	11.4	11.9	12.4	13.0	13.5	14.1	14.6	15.2	15.7	16.2
156	10.7	11 2	11.8	12.3	12.8	13.4	13.9	14.4	15.0	15.5	16.0
160	10.4	10.9	11.5	12.0	12.5	13 0	13.5	14.1	14.6	15.1	15.6
164	10.2	10.7	11.2	11.7	12.2	12.7	13.2	13.7	14.2	14.7	15.2
166	10.0	10.5	11.0	11.5	12.0	12.6	13.1	13.5	14.1	14.6	15.1
170	9.8	10.3	10.8	11.3	11.8	12.3	12.7	13.2	13.7	14.2	14.7
174	9.6	10.1	10.5	11.0	11.5	12.0	12.5	12.9	13.4	13.9	14.4
176	9.5	9.9	10.4	10.9	11.4	11.8	12.3	12.8	13.3	13.7	14.2
180	9.3	9.7	10.2	10.6	11.1	11.6	12.0	12.5	13.0	13.4	13.9

Picks per inch.	Picks per minute.										
	155	160	165	170	175	180	185	190	195	200	205
20	129.2	133.3	137.5	141.7	145.8	150.0	154.2	158.3	162.5	166.7	170.8
22	117.4	121.2	125.0	128.8	132.6	136.4	140.2	143.9	147.7	151.5	155.3
24	107.6	111.1	114.6	118.1	121.5	125.0	128.5	131.9	135.4	138.9	142.4
26	99.4	102.6	105.8	109.0	112.2	115.4	118.6	121.8	125.0	128.2	131.4
28	92.3	95.2	98.2	101.2	104.2	107.1	110.1	113.1	116.1	119.0	122.0
30	86.1	88 9	91.7	94.4	97.2	100.0	102.8	105.5	108.3	111.1	113.9
32	80.7	83.3	85.9	88.5	91.1	93.7	96.4	99.0	101.6	104.2	106.8
34	76.0	78.4	80.9	83.3	85.8	88.2	90.7	93.1	95.6	98.0	100.5
36	71.8	74.1	76.4	78.7	81.0	83.3	85.6	88.0	90.3	92.6	94.9
38	68.0	70.2	72.4	74.6	76.8	78.9	81.1	83.3	85.5	87.7	89.9
40	64.6	66.7	68.7	70.8	72.9	75.0	77.1	79.2	81.3	83.3	85.4
42	61.5	63.5	65.5	67.5	69.4	71.4	73.4	75.4	77.4	79.4	81.3
44	58.7	60.6	62.5	64.4	66.3	68.2	70.1	72.0	73.9	75.8	77.7
46	56.2	58.0	59.8	61.6	63.4	65.2	67.0	68.8	70.7	72.5	74.3
48	53.8	55.6	57.3	59.0	60.8	62.5	64.2	66.0	67.7	69.4	71.2
50	51.7	53.3	55.0	56.7	58.3	60.0	61.7	63.3	65.0	66.7	68.3
52	49.7	51.3	52.9	54.5	56.1	57.7	59.3	60.9	62.5	64.1	65.7
54	47.8	49.4	50.9	52.5	54.0	55.6	57.1	58.6	60.2	61.7	63.3
56	46.1	47.6	49.1	50.6	52.1	53.6	55.1	56.5	58.0	59.5	61.0
58	44.5	46.0	47.4	48.8	50.3	51.7	53.2	54.6	56.0	57.5	58.9
60	43.1	44.4	45.8	47.2	48.6	50.0	51.4	52.8	54.2	55.6	56.9
62	41.7	43.0	44.4	45.7	47.0	48.4	49.7	51.1	52.4	53.8	55.1
64	40.4	41.7	43.0	44.3	45.6	46.9	48.2	49.5	50.8	52.1	53.4
66	39.1	40.4	41.7	42.9	44.2	45.5	46.7	48.0	49.2	50.5	51.8
68	38.0	39.2	40.4	41.7	42.9	44.1	45.3	46.6	47.8	49.0	50.2
70	36.9	38.1	39.3	40.5	41.7	42.9	44.0	45.2	46.4	47.6	48.8
72	35.9	37.0	38.2	39.4	40.5	41.7	42.8	44.0	45.1	46.3	47.5
74	34.9	36.0	37.2	38.3	39.4	40.5	41.7	42.8	43.9	45.0	46.2
76	34.0	35.1	36.2	37.3	38.4	39.5	40.6	41.7	42.8	43.9	45.0
78	33.1	34.2	35.3	36.3	37.4	38.5	39.5	40.6	41.7	42.7	43.8
80	32.3	33.3	34.4	35.4	36.5	37.5	38.5	39.6	40.6	41.7	42.7
82	31.5	32.5	33.5	34.6	35.6	36.6	37.6	38.6	39.6	40.7	41.7
84	30.8	31.7	32.7	33.7	34.7	35.7	36.6	37.7	38.7	39.7	40.7
86	30.0	31.0	32.0	32.9	33.9	34.9	35.8	36.8	37.8	38.8	39.7
88	29.4	30.3	31.3	32.2	33.1	34.1	35.0	36.0	36.9	37.9	38.8
90	28.7	29.6	30.6	31.5	32.4	33.3	34.3	35.2	36.1	37.0	38.0
92	28.1	29.0	29.9	30.8	31.7	32.6	33.5	34.4	35.3	36.2	37.1
94	27.5	28.4	29.3	30.1	31.0	31.9	32.8	33.7	34.6	35.5	36.3
96	26.9	27.8	28.6	29.5	30.4	31.3	32.1	33.0	33.9	34.7	35.6
98	26.4	27.2	28.1	28.9	29.8	30.6	31.5	32.3	33.2	34.0	34.9
100	25.8	26.7	27.5	28.3	29.2	30.0	30.8	31.7	32.5	33.3	34.4
102	25.3	26.1	27.0	27.8	28.6	29.4	30.2	31.0	31.9	32.7	33.5
104	24.8	25.6	26.4	27.2	28.0	28.8	29.6	30.4	31.3	32.1	32.9
106	24.4	25.2	25.9	26.7	27.5	28.3	29.1	29.9	30.7	31.4	32.2
108	23.9	24.7	25.5	26.2	27.0	27.8	28.5	29.3	30.1	30.9	31.6
110	23.5	24.2	25.0	25.8	26.5	27.3	28.0	28.8	29.5	30.3	31.1
112	23.1	23.8	24.6	25.3	26.0	26.8	27.5	28.3	29.0	29.8	30.5
114	22.7	23.4	24.1	24.9	25.6	26.3	27.0	27.8	28.5	29.2	30.0
116	22.3	23.0	23.7	24.4	25.1	25.9	26.6	27.3	28.0	28.7	29.5
118	21.9	22.6	23.3	24.0	24.7	25.4	26.1	26.8	27.5	28.2	29.0
120	21.5	22.2	22.9	23.6	24.3	25.0	25.7	26.4	27.1	27.8	28.5
122	21.2	21.9	22.5	23.2	23.9	24.6	25.3	26.0	26.6	27.3	28.0
124	20.8	21.5	22.2	22.8	23.5	24.2	24.9	25.5	26.2	26.9	27.6
126	20.5	21.2	21.8	22.5	23.1	23.8	24.5	25.1	25.8	26.5	27.1
128	20.2	20.8	21.5	22.1	22.8	23.4	24.1	24.7	25.4	26.0	26.7
130	19.9	20.5	21.2	21.8	22.4	23.1	23.7	24.4	25.0	25.6	26.3
134	19.3	19.9	20.5	21.1	21.8	22.4	23.0	23.6	24.3	24.9	25.5
136	19.0	19.6	20.2	20.8	21.4	22.1	22.7	23.3	23.9	24.5	25.1
140	18.5	19.0	19.6	20.2	20.8	21.4	22.0	22.6	23.2	23.8	24.4
144	17.9	18.5	19.1	19.7	20.3	20.8	21.4	22.0	22.6	23.1	23.7
146	17.7	18.3	18.8	19.4	20.0	20.5	21.1	21.7	22.3	22.8	23.4
150	17.2	17.8	18.3	18.9	19.4	20.0	20.6	21.1	21.7	22.2	22.8
154	16.8	17.3	17.9	18.4	18.9	19.5	20.0	20.6	21.1	21.6	22.2
156	16.6	17.1	17.6	18.2	18.7	19.2	19.8	20.3	20.8	21.4	21.9
160	16.1	16.7	17.2	17.7	18.2	18.7	19.3	19.8	20.3	20.8	21.4
164	15.8	16.3	16.8	17.3	17.8	18.3	18.8	19.3	19.8	20.3	20.8
166	15.6	16.1	16.6	17.1	17.6	18.1	18.6	19.1	19.6	20.1	20.6
170	15.2	15.7	16.2	16.7	17.2	17.6	18.1	18.6	19.1	19.6	20.1
174	14.8	15.4	15.8	16.3	16.8	17.2	17.7	18.2	18.7	19.2	19.6
176	14.7	15.2	15.6	16.1	16.6	17.0	17.5	18.0	18.5	18.9	19.4
180	14.4	14.8	15.3	15.7	16.2	16.7	17.1	17.6	18.1	18.5	19.0

REED TABLE.

Ends per Inch.	Ends in Cloth.	PLAIN CLOTH.			FOR DRILLS.		
		Dents per Inch.	Two Ends per Reed Dent. Total Dents.	Width of Reed or Spread.	Dents in Inch.	Three Ends per Reed Dent. Total Dents.	Width of Reed or Inches Spread.
32	1176	14.67	576	39.25	10.16	392	38.58
34	1248	15.59	612	39.25	10.79	416	38.55
36	1320	16.51	648	39.25	11.42	440	38.52
38	1392	17.42	684	39.25	12.06	464	38.47
40	1464	18.34	720	39.25	12.69	488	38.47
42	1536	19.26	756	39.25	13.33	512	38.40
44	1608	20.17	792	39.25	13.96	536	38.37
46	1680	21.09	828	39.25	14.60	560	38.35
48	1752	22.01	864	39.25	15.23	584	38.34
50	1824	22.93	900	39.25	15.87	608	38.33
52	1896	23.85	936	39.25	16.50	632	38.32
54	1968	24.77	972	39.25	17.14	656	38.27
56	2040	25.68	1008	39.25	17.77	680	38.26
58	2112	26.60	1044	39.25	18.41	704	38.24
60	2184	27.51	1080	39.25	19.04	728	38.23
62	2256	28.43	1116	39.25	19.68	752	38.20
64	2328	29.35	1152	39.25	20.32	776	38.19
66	2400	30.22	1188	39.25	20.95	800	38.18
68	2472	31.18	1224	39.25	21.58	824	38.18
70	2544	32.10	1260	39.25	22.22	848	38.17
72	2616	33.02	1296	39.25	22.85	872	38.16
74	2688	33.94	1332	39.25	23.49	896	38.14
76	2760	34.85	1368	39.25	24.12	920	38.14
78	2832	35.77	1404	39.25	24.76	944	38.13
80	2904	36.69	1440	39.25	25.39	968	38.12
82	2976	37.60	1476	39.25	26.63	992	38.12
84	3048	38.52	1512	39.25	26.66	1016	38.12
86	3120	39.44	1548	39.25	27.30	1040	38.09
88	3192	40.35	1584	39.25	27.94	1064	38.08
90	3264	41.27	1620	39.25	28.58	1088	38.07
92	3336	42.19	1656	39.25	29.22	1112	38.06
94	3408	43.11	1692	39.25	29.86	1136	38.05
96	3480	44.02	1728	39.25	30.50	1160	38.03
98	3552	44.92	1764	39.25	31.14	1184	38.02
100	3624	45.85	1800	39.25	31.78	1208	38.00

This table is made out for cloth 36″ wide—all other widths of cloth, proportion must be made. Twenty-four ends are allowed in every case for selvage.

For two harness plain, eyes on each harness = Total dents.
For three harness drill, eyes on each harness = Total dents.

Table to Facilitate the Conversion of Yards to the Pound to Their Decimal Equivalent.

YDS. TO LB.	EQUIVALENT.	YDS. TO LB.	EQUIVALENT.	YDS. TO LB.	EQUIVALENT.	YDS. TO LB.	EQUIVALENT.	YDS. TO LB.	EQUIVALENT.	YDS. TO LB.	EQUIVALENT.	YDS. TO LB.	EQUIVALENT.	YDS. TO LB.	EQUIVALENT.
1.00	1.0000	2.00	.5000	3.00	.3333	4.00	.2500	5.00	.2000	6.00	.1667	7.00	.1429	8.00	.1250
.05	.9524	.05	.4878	.05	.3279	.05	.2469	.05	.1980	.05	.1653	.05	.1418	.05	.1242
.10	.9091	.10	.4762	.10	.3226	.10	.2439	.10	.1961	.10	.1639	.10	.1408	.10	.1235
.15	.8696	.15	.4651	.15	.3175	.15	.2410	.15	.1942	.15	.1626	.15	.1399	.15	.1227
.20	.8333	.20	.4545	.20	.3125	.20	.2381	.20	.1923	.20	.1613	.20	.1389	.20	.1220
.25	.8000	.25	.4444	.25	.3077	.25	.2353	.25	.1905	.25	.1600	.25	.1379	.25	.1212
.30	.7692	.30	.4348	.30	.3030	.30	.2326	.30	.1887	.30	.1587	.30	.1370	.30	.1205
.35	.7407	.35	.4255	.35	.2985	.35	.2299	.35	.1869	.35	.1575	.35	.1361	.35	.1198
.40	.7143	.40	.4167	.40	.2941	.40	.2273	.40	.1852	.40	.1562	.40	.1351	.40	.1190
.45	.6897	.45	.4082	.45	.2899	.45	.2247	.45	.1835	.45	.1550	.45	.1342	.45	.1183
.50	.6667	.50	.4000	.50	.2857	.50	.2222	.50	.1818	.50	.1538	.50	.1333	.50	.1176
.55	.6452	.55	.3922	.55	.2817	.55	.2198	.55	.1802	.55	.1527	.55	.1325	.55	.1170
.60	.6250	.60	.3846	.60	.2778	.60	.2174	.60	.1786	.60	.1515	.60	.1316	.60	.1163
.65	.6061	.65	.3774	.65	.2740	.65	.2151	.65	.1770	.65	.1504	.65	.1307	.65	.1156
.70	.5882	.70	.3704	.70	.2703	.70	.2128	.70	.1754	.70	.1493	.70	.1299	.70	.1149
.75	.5714	.75	.3636	.75	.2667	.75	.2105	.75	.1739	.75	.1481	.75	.1290	.75	.1143
.80	.5556	.80	.3571	.80	.2632	.80	.2083	.80	.1724	.80	.1471	.80	.1282	.80	.1136
.85	.5405	.85	.3509	.85	.2597	.85	.2062	.85	.1709	.85	.1460	.85	.1274	.85	.1130
.90	.5263	.90	.3448	.90	.2564	.90	.2041	.90	.1695	.90	.1449	.90	.1266	.90	.1124
.95	.5128	.95	.3390	.95	.2532	.95	.2020	.95	.1681	.95	.1439	.95	.1258	.95	.1117

CLOTH CONSTRUCTION TABLES.

To enable any person having four of the elements of a piece of cloth given, to find the fifth, or to construct a piece of cloth of any required reed, pick and weight.

Use:—These tables are constructed for 36″ cloth. For any other width, proportion must be made. The decimal equivalent opposite yards is divided by two, as warp and filling form each one half of any cloth when of equal number, pick or reed. If of different number, pick or reed, due proportion, as indicated by decimal equivalent. In calculating weights of cloth where unequal yarns, reed or pick is used, the weight in pounds (decimal equivalent) must always be used.

Average numbers of yarn, reed or pick can be taken direct from tables without further calculation.

The elements of a piece of cloth are five in number; reed, pick, warp, filling and weight. Having any four of these given to find the fifth:—

1. Reed, pick, warp, filling, to find weight.
2. Reed, pick, warp, weight " " filling.
3. Reed, pick, filling, weight " " warp.
4. Reed, filling, warp, weight " " pick.
5. Pick, filling, warp, weight " " reed.

FIRST.

Reed	Pick	Warp	Filling	Weight		As per tables.
48	52	18.50	20		=	4 yards.

Opposite 18.50 yarn under 48 reed is .1250 of a pound.
" 20 " " 52 pick is .1250

4 yards = .2500

SECOND.

Reed	Pick	Warp	Yards	
48	52	18.50	4	
	4 yards		=	.2500

Opposite 18.50 warp under 48 reed is .1250 (subtract.)

Opposite .1250 under 52 reed is .1250
20° yarn filling number required.

THIRD.

Reed	Pick	Filling	Weight		
48	52	20	4		
	4 yards to pound			=	.2500

Opposite 20 yarn under 52 reed is .1250

Opposite .1250 under 48 reed (see tables) is
18.50 warp number .1250

FOURTH.

Reed	Filling	Warp	Weight		
48	20	18.50	4 yards		
		4 yards		=	.2500
Opposite 18.50 warp under 48 reed is					.1250
		Find opp. .1250 No. 20 filling			.1250
		and at head of column is 52 reed.			

FIFTH.

Pick	Filling	Warp	Weight		
52	18.50	20	4 yards	=	.2500
	Weight opposite 20 under 52 reed is				.1250
	Find opp. .1250 No. 1850 and at head of column is 48 reed.				.1250

Required a piece of cloth 60 reed, 60 pick, 20 warp, to weigh 4 yards.

4 yards	=	.2500
Opposite 20 warps under 60 reed is		.1444
Opposite .1056 and under 60 picks is		.1056

27.37 filling required.

While the tables may be found of great convenience the same results can be attained by use of the Schaer Scale described elsewhere.

Yards per lb.	Reed. Decimal Equivalent	30	32	34	36	38
		Numbers.				
1.00	.5000		3.08	3.27	3.46	3.65
.05	.4762		.23	.43	.64	.84
.10	.4545		.38	.60	.81	4.02
.15	.4348		.54	.76	.98	.20
.20	.4167		.69	.92	4.16	.39
.25	.4000		.85	4.09	.33	.57
.30	.3846		4.00	.25	.50	.75
.35	.3704		.16	.42	.68	.94
.40	.3571		.31	.58	.85	5.12
.45	.3448		.46	.74	5.02	.30
.50	.3333		.62	.91	.20	.48
.55	.3226		.77	5.07	.37	.67
.60	.3125		.93	.23	.54	.85
.65	.3030		5.08	.40	.72	6.03
.70	.2941		.23	.56	.89	.22
.75	.2857		.39	.72	6.06	.40
.80	.2778		.54	.89	.24	.58
.85	.2703		.70	6.05	.41	.76
.90	.2632		.85	.22	.58	.95
.95	.2564		6.00	.38	.76	7.13

Yards per lb.	Reed. Decimal Equivalent	40	42	44	46	48
		Numbers.				
1.00	.5000	3.85	4.04	4.23	4.42	4.62
.05	.4762	4.04	.24	.44	.65	.85
.10	.4545	.23	.44	.66	.87	5.08
.15	.4348	.42	.65	.87	5.09	.31
.20	.4167	.62	.85	5.08	.31	.54
.25	.4000	.81	5.05	.29	.53	.77
.30	.3846	5.00	.25	.50	.75	6.00
.35	.3704	.20	.46	.71	.98	.24
.40	.3571	.39	.66	.93	6.20	.47
.45	.3448	.58	.86	6.14	.42	.70
.50	.3333	.77	6.06	.35	.64	.93
.55	.3226	.97	.26	.56	.86	7.16
.60	.3125	6.16	.47	.77	7.08	.39
.65	.3030	.35	.67	.99	.30	.62
.70	.2941	.54	.87	7.20	.53	.85
.75	.2857	.74	7.07	.41	.75	8.08
.80	.2778	.93	.28	.62	.87	.32
.85	.2703	7.12	7.48	.83	8.19	.55
.90	.2632	.31	.68	8.04	.41	.78
.95	.2564	.51	.88	.26	.63	9.01

	Reed.	50	52	54	56	58
Yards per lb.	Decimal Equivalent	Numbers.				
1.00	.5000	4.81	5.00	5.20	5.39	5.58
.05	.4762	5.05	.25	.46	.66	.86
.10	.4545	.29	.50	.72	.93	6.14
.15	.4348	.53	.75	.98	6.20	.42
.20	.4167	.77	6.00	6.24	.47	.70
.25	.4008	6.01	.25	.50	.74	.98
.30	.3846	.25	.50	.76	7.01	7.26
.35	.3704	.50	.75	7.02	.28	.54
.40	.3571	.74	7.00	.28	.54	.81
.45	.3448	.98	.25	.54	.81	8.09
.50	.3333	7.22	.50	.80	8.08	.37
.55	.3226	.46	.75	8.06	.35	.65
.60	.3125	.70	8.00	.32	.62	.93
.65	.3030	.94	.25	.58	.89	9.21
.70	.2941	8.18	.50	.84	9.16	.49
.75	.2857	.42	.75	9.10	.43	.77
.80	.2778	.66	9.00	.36	.70	10.05
.85	.2703	.90	.25	.62	.97	.33
.90	.2632	9.14	.50	.88	10.24	.61
.95	.2564	.38	.75	10.14	.51	.88

	Reed.	60	62	64	66	68
Yards per lb.	Decimal Equivalent	Numbers.				
1.00	.5000	5.77	5.97	6.16	6.35	6.54
.05	.4762	6.06	6.26	.47	.67	.87
.10	.4545	.35	.56	.77	.99	7.20
.15	.4348	.64	.86	7.08	7.30	.53
.20	.4167	.93	7.16	.39	.62	.85
.25	.4000	7.22	.46	.70	.94	8.18
.30	.3846	.51	.76	8.01	8.26	.51
.35	.3704	.80	8.06	.32	.58	.84
.40	.3571	8.08	.35	.62	.89	9.16
.45	.3448	.37	.65	.93	9.21	.49
.50	.3333	.66	.95	9.24	.53	.82
.55	.3226	.95	9.25	.55	.85	10.14
.60	.3125	9.24	.55	.86	10.16	.47
.65	.3030	.53	.85	10.16	.48	.80
.70	.2941	.82	10.15	.47	.80	11.13
.75	.2857	10.11	.44	.78	11.12	.45
.80	.2778	.40	.74	11.09	.44	.78
.85	.2703	.68	11.04	.40	.76	12.11
.90	.2632	.97	.34	.71	12.07	.44
.95	.2564	11.26	.64	12.01	.39	.76

Yards per lb.	Reed. Decimal Equiv'nt	70	72	74	76	78	80
		Numbers.					
1.00	.5000	6.74	6.93	7.12	7.31	7.51	7.70
.05	.4762	7.07	7.28	.48	.68	.88	8.08
.10	.4545	.41	.62	.83	8.05	8.26	.47
.15	.4348	.75	.97	8.19	.41	.63	.85
.20	.4167	8.08	8.32	.55	.78	9.01	9.24
.25	.4000	.42	.66	.90	9.14	.38	.63
.30	.3846	.76	9.01	9.26	.51	.76	10.01
.35	.3704	9.10	.36	.62	.88	10.14	.40
.40	.3571	.43	.70	.97	10.24	.51	.78
.45	.3448	.77	10.05	10.33	.61	.89	11.17
.50	.3333	10.11	.40	.68	.97	11.26	.55
.55	.3226	.44	.74	11.04	11.34	.64	.94
.60	.3125	.78	11.09	.40	.71	12.01	12.32
.65	.3030	11.12	.44	.75	12.07	.39	.71
.70	.2941	.45	.78	12.11	.44	.76	13.09
.75	.2857	.79	12.13	.47	.80	13.14	.48
.80	.2778	12.13	.48	.82	13.17	.52	.86
.85	.2703	.47	.82	13.18	.53	.89	14.25
.90	.2632	.80	13.17	.53	.90	14.27	.63
.95	.2564	13.14	.52	89	14.27	.64	15.02

Yards per lb.	Reed. Decimal Equivalent	82	84	86	88	90
		Numbers.				
1.00	.5000	7.89	8.08	8.28	8.47	8.66
.05	.4762	8.29	.49	.69	.98	9.10
.10	.4545	.68	.89	9.10	9.32	.53
.15	.4348	9.08	9.30	.52	.74	.96
.20	.4167	.47	.70	.93	10.16	10.40
.25	.4000	.87	10.11	10.35	.59	.83
.30	.3846	10.26	.51	.76	11.01	11.26
.35	.3704	.66	.92	11.18	.44	.70
.40	.3571	11.05	11.32	.59	.86	12.13
.45	.3448	.45	.72	12.00	12.28	.56
.50	.3333	.84	12.13	.42	.71	13.00
.55	.3226	12.23	.53	.83	13.13	.43
.60	.3125	.63	.94	13.25	.55	.86
.65	.3030	13.02	13.34	.66	.98	14.30
.70	.2941	.42	.75	14.07	14.40	.73
.75	.2857	.81	14.15	.49	.83	15.16
.80	.2778	14.21	.59	.90	15.25	.60
.85	.2703	.60	.96	15.32	.67	16.03
.90	.2632	15.00	15.36	.73	16.10	.46
.95	.2564	.39	.77	16.14	.52	.90

	Reed.	20	22	24	26	28
Yards per lb.	Decimal Equivalent	Numbers.				
2.00	.2500	3.85	4.23	4.62	5.00	5.39
.05	.2439	3.94	4.34	4.73	.13	.52
.10	.2381	4.04	4.44	.85	.25	.66
.15	.2326	4.14	4.55	.96	.38	.79
.20	.2273	4.23	4.66	5.08	.50	.93
.25	.2222	4.33	4.76	.20	.63	6.06
.30	.2174	4.42	4.87	.31	.75	.20
.35	.2128	4.52	4.97	.43	.88	.33
.40	.2083	4.62	5.08	.54	6.00	.47
.45	.2041	4.71	5.19	.66	.13	.60
.50	.2000	4.81	5.29	.77	.25	.74
.55	.1961	4.91	5.40	.89	.38	.87
.60	.1923	5.00	5.50	6.00	.50	7.01
.65	.1887	5.10	5.61	.12	.63	.14
.70	.1852	5.20	5.72	.24	.75	.28
.75	.1818	5.29	5.82	.35	.87	.41
.80	.1786	5.39	5.93	.47	7.00	.54
.85	.1754	5.48	6.03	.58	.12	.68
.90	.1724	5.58	6.14	.70	.25	.81
.95	.1695	5.68	6.24	.81	.39	.95

	Reed.	30	32	34	36	38
Yards per lb.	Decimal Equivalent	Numbers.				
2.00	.2500	5.77	.16	.54	.93	.31
.05	.2439	.92	.31	.71	7.10	.50
.10	.2381	6.06	.47	.87	.28	.68
.15	.2326	.21	.62	7.03	.45	.86
.20	.2273	.35	.77	.20	.62	8.05
.25	.2222	.50	.93	.36	.80	.23
.30	.2174	.64	7.08	.53	.97	.41
.35	.2128	.78	.24	.69	8.14	.59
.40	.2083	.93	.39	.85	.32	.78
.45	.2041	7.07	.54	8.02	.49	.96
.50	.2000	.22	.70	.18	.66	9.14
.55	.1961	.36	.85	.34	.84	.33
.60	.1923	.51	8.01	.51	9.01	.51
.65	.1887	.65	.16	.67	.18	.69
.70	.1852	.80	.32	.84	.36	.88
.75	.1818	.94	.47	9.00	.53	10.06
.80	.1786	8.08	.62	.16	.70	.24
.85	.1754	.23	.78	.33	.88	.42
.90	.1724	.37	.93	.49	10.05	.61
.95	.1695	.52	9.09	.65	.22	.79

Yards per lb.	Reed. Decimal Equivalent	40	42	44	46	48
		Numbers.				
2.00	.2500	.70	8.08	.47	.85	.24
.05	.2439	.89	.29	.68	9.08	.47
.10	.2381	8.08	.49	.89	.30	.70
.15	.2326	.28	.69	9.10	.52	.93
.20	.2273	.47	.89	.32	.74	10.16
.25	.2222	8.66	9.10	.53	.96	.39
.30	.2174	.85	.30	.74	10.18	.63
.35	.2128	9.05	.50	.95	.41	.86
.40	.2083	.24	.70	10.16	.63	11.09
.45	.2041	.43	.90	.37	.85	.32
.50	.2000	.63	10.11	.59	11.07	.55
.55	.1961	.82	.31	.80	.29	.78
.60	.1923	10.01	.51	.91	.51	12.01
.65	.1887	.20	.71	11.22	.73	.24
.70	.1852	.40	.92	.43	.96	.47
.75	.1818	10.59	11.12	.65	12.18	.71
.80	.1786	.78	.32	.86	.40	.94
.85	.1754	.97	.52	12.07	.62	13.17
.90	.1724	11.17	.72	.28	.84	.40
.95	.1695	.36	.93	.49	13.06	.63

Yards per lb.	Reed. Decimal Equivalent	50	52	54	56	58
		Numbers.				
2.00	.2500	.63	10.00	.40	.78	11.16
.05	.2439	.87	.25	.66	11.05	.44
.10	.2381	10.11	.50	.92	.32	.72
.15	.2326	.35	.75	11.18	.59	12.00
.20	.2273	.59	11.00	.44	.86	.28
.25	.2222	.83	.25	.70	12.13	.56
.30	.2174	11.07	.50	.96	.40	.84
.35	.2128	.31	.75	12.22	.67	13.12
.40	.2083	.55	12.01	.48	.94	.40
.45	.2041	.79	.26	.74	13.21	.68
.50	.2000	12.03	.51	13.00	.48	.96
.55	.1961	.27	.76	.26	.75	14.24
.60	.1923	.51	13.01	.52	14.02	.51
.65	.1887	.75	.26	.78	.29	.79
.70	.1852	13.00	.51	14.04	.56	15.07
.75	.1818	.24	.76	.30	.83	.35
.80	.1786	.48	14.01	.56	15.00	.63
.85	.1754	.72	.26	.82	.36	.91
.90	.1724	.96	.51	15.08	.63	16.19
.95	.1695	14.20	.76	.34	.90	.47

Yards per lb.	Reed. Decimal Equivalent	60	62	64	66	68
		Numbers				
2.00	.2500	.55	.94	.32	.71	13.09
.05	.2439	.84	12.23	.63	13.02	.42
.10	.2381	12.13	.53	.94	.34	.75
.15	.2326	.42	.83	13.25	.66	14.07
.20	.2273	.71	13.13	.55	.98	.40
.25	.2222	13.00	.43	.86	14.30	.73
.30	.2174	.28	.73	14.17	.61	15.06
.35	.2128	.57	14.03	.48	.93	.38
.40	.2083	.86	.32	.79	15.25	.71
.45	.2041	14.45	.62	15.09	.57	16.04
.50	.2000	.44	.92	.40	.88	.37
.55	.1961	.73	15.22	.71	16.20	.69
.60	.1923	15.02	.52	16.02	.52	17.02
.65	.1887	.31	.82	.33	.84	.35
.70	.1852	.60	16.12	.64	17.16	.68
.75	.1818	.88	.41	.94	.47	18.00
.80	.1786	16.17	.71	17.25	.79	.33
.85	.1754	.46	17.01	.56	18.11	.66
.90	.1724	.75	.31	.87	.43	.99
.95	.1695	17.04	.61	18.18	.74	19.31

Yards per lb.	Reed. Decimal Equiv'nt	70	72	74	76	78	80
		Numbers.					
2.00	.2500	.48	.86	14.25	.63	15.02	.40
.05	.2439	.81	14.21	.60	15.00	.39	.79
.10	.2381	14.15	.55	.96	.36	.77	16.17
.15	.2326	.49	.90	15.32	.73	16.14	.56
.20	.2273	.83	15.25	.67	16.10	.52	.94
.25	.2222	15.16	.59	16.03	.46	.90	17.33
.30	.2174	.50	.94	.39	.83	17.27	.71
.35	.2128	.84	16.29	.74	17.21	.65	18.10
.40	.2083	16.17	.63	17.10	.58	18.02	.48
.45	.2041	.51	.98	.45	.95	.40	.87
.50	.2000	.85	17.33	.81	18.31	.77	19.26
.55	.1961	17.18	.67	18.17	.68	19.15	.64
.60	.1923	.52	18.02	.52	19.04	.52	20.03
.65	.1887	.86	.37	.88	.41	.90	.41
.70	.1852	18.20	.71	19.24	.78	20.28	.80
.75	.1818	.53	19.06	.59	20.14	.65	21.18
.80	.1786	.74	.41	.95	.51	21.03	.59
.85	.1754	19.21	.75	20.30	.87	.40	.95
.90	.1724	.54	20.10	.66	21.24	.78	22.34
.95	.1695	.88	.45	21.02	.68	22.15	.72

Yards per lb.	Reed. Decimal Equivalent	82	84	86	88	90
		Numbers.				
2.00	.2500	.79	16.17	.56	.94	17.33
.05	.2439	16.18	.58	.97	17.37	.76
.10	.2381	.58	.98	17.39	.79	18.20
.15	.2326	.97	17.39	.80	18.21	.63
.20	.2273	17.37	.79	18.21	.64	19.06
.25	.2222	.76	18.20	.63	19.06	.50
.30	.2174	18.16	.60	19.04	.49	.93
.35	.2128	.55	19.00	.46	.91	20.36
.40	.2083	.95	.41	.87	20.33	.80
.45	.2041	19.34	.81	20.29	.76	21.23
.50	.2000	.74	20.22	.70	21.18	.66
.55	.1961	20.13	.62	21.11	.60	22.10
.60	.1923	.53	21.03	.53	22.03	.53
.65	.1887	.92	.43	.94	.45	.96
.70	.1852	21.32	.84	22.36	.88	23.40
.75	.1818	.71	22.24	.77	23.30	.83
.80	.1786	22.11	.64	23.18	.72	24.26
.85	.1754	.50	23.05	.60	24.15	24.70
.90	.1724	.90	.45	24.01	.57	25.13
.95	.1695	23.29	.86	.43	.99	.56

Yards per lb.	Reed. Decimal Equivalent	20	22	24	26	28
		Numbers.				
3.00	.1667	57.78	6.35	6.93	75.11	8.08
.05	.1639	8.74	.46	7.04	6.36	.22
.10	.1613	9.70	.65	.16	7.61	.35
.15	.1587	60.66	.66	.28	8.87	.49
.20	.1562	61.63	.77	.39	80.12	.62
.25	.1538	2.59	.88	.51	1.37	.76
.30	.1515	3.55	.99	.62	2.62	.89
.35	.1493	4.52	7.09	.74	3.87	9.03
.40	.1471	5.48	7.20	.85	5.13	.16
.45	.1449	6.44	.30	.97	6.38	.30
.50	.1429	7.41	.41	8.08	7.63	.43
.55	.1408	8.37	.52	.20	8.88	.57
.60	.1389	9.33	.62	.31	90.13	.70
.65	.1370	70.29	.73	.43	1.39	.84
.70	.1351	1.26	.83	.55	2.64	.97
.75	.1333	2.22	.94	.66	3.89	10.11
.80	.1316	3.18	8.05	.78	5.14	.24
.85	.1299	4.15	.15	.89	6.39	.38
.90	.1282	5.11	.26	9.01	7.65	.51
.95	.1266	6.07	.36	.12	8.90	.65

Yards per lb.	Reed. Decimal Equivalent	30	32	34	36	38
		Numbers				
3.00	.1667	.66	.24	.82	.40	10.97
.05	.1639	.81	.39	.98	.57	11.16
.10	.1613	.95	.55	10.15	.74	.34
.15	.1587	9.10	.70	.31	.92	.52
.20	.1562	.24	.86	.47	11.09	.71
.25	.1538	.38	10.01	.64	.26	.89
.30	.1515	.53	.16	.80	.44	12.07
.35	.1493	.67	.32	.96	.61	.25
.40	.1471	.82	.47	11.13	.78	.44
.45	.1449	.96	.63	.29	.96	.62
.50	.1429	10.11	.78	.45	12.13	.80
.55	.1408	.25	.93	.62	.30	.99
.60	.1389	.39	11.09	.78	.48	13.17
.65	.1370	.54	.24	.95	.65	.35
.70	.1351	.68	.49	12.11	.82	.53
.75	.1333	.83	.55	.27	.99	.72
.80	.1316	.97	.70	.44	13.17	.90
.85	.1299	11.12	.86	.60	.34	14.08
.90	.1282	.26	12.01	.76	.51	.27
.95	.1266	.41	.17	.93	.69	.45

Yards per lb.	Reed. Decimal Equivalent	40	42	44	46	48
		Numbers.				
3.00	.1667	.55	12.13	.70	.28	.86
.05	.1639	.74	.33	.92	.51	14.09
.10	.1613	.94	.53	13.13	.73	.32
.15	.1587	12.13	.74	.34	.95	.55
.20	.1562	.32	.94	.55	14.17	.79
.25	.1538	.51	13.14	.76	.39	15.02
.30	.1515	.71	.34	.98	.61	.25
.35	.1493	.80	.54	14.19	.83	.48
.40	.1471	13.09	.75	.40	15.06	.71
.45	.1449	.28	.95	.61	.28	.94
.50	.1429	.48	14.15	.83	.50	16.17
.55	.1408	.67	.35	15.04	.72	.40
.60	.1389	.86	.56	.25	.94	.64
.65	.1370	14.05	.76	.46	16.16	.87
.70	.1351	.25	.96	.67	.39	17.10
.75	.1333	.44	15.16	.88	.61	.33
.80	.1316	.63	.36	16.10	.83	.56
.85	.1299	.83	.57	.31	17.05	.79
.90	.1282	15.02	.77	.52	.27	18.02
.95	.1266	.21	.97	.73	.49	.25

Yards per lb.	Reed. Decimal Equivalent	50	52	54	56	58
		Numbers.				
3.00	.1667	.44	15.02	.60	16.17	.75
.05	.1639	.68	.27	.86	.44	17.03
.10	.1613	.92	.52	16.12	.71	.31
.15	.1587	15.16	.77	.38	.98	.59
.20	.1562	.40	16.02	.64	17.25	.87
.25	.1538	.64	.27	.90	.52	18.15
.30	.1515	.88	.52	17.16	.79	.43
.35	.1493	16.13	.77	.42	18.06	.71
.40	.1471	.37	17.02	.68	.33	.99
.45	.1449	.61	.27	.94	.60	19.26
.50	.1429	.85	.52	18.20	.87	.54
.55	.1408	17.09	.77	.46	19.14	.82
.60	.1389	.33	18.02	.72	.41	20.10
.65	.1370	.57	.27	.98	.68	.38
.70	.1351	.81	.52	19.24	.95	.66
.75	.1333	18.05	.77	.50	20.22	.94
.80	.1316	.29	19.02	.76	.49	21.22
.85	.1299	.53	.27	20.02	.76	.50
.90	.1282	.77	.52	.28	21.03	.78
.95	.1266	19.01	.78	.54	.30	22.06

Yards per lb.	Reed. Decimal Equivalent	60	62	64	66	68
		Numbers				
3.00	.1667	.33	.91	.48	19.06	.64
.05	.1639	.62	18.21	.79	.38	.97
.10	.1613	.91	.50	19.10	.70	20.30
.15	.1587	18.20	.80	.41	20.02	.62
.20	.1562	.48	19.10	.72	.33	.95
.25	.1538	.77	.40	20.03	.65	21.28
.30	.1515	19.06	.70	.33	.97	.60
.35	.1493	.35	20.00	.64	21.29	.93
.40	.1471	.64	.30	.95	.60	22.26
.45	.1449	.93	.59	21.26	.92	.59
.50	.1429	20.22	.89	.57	22.24	.91
.55	.1408	.51	21.19	.87	.56	23.24
.60	.1389	.80	.49	22.18	.88	.57
.65	.1370	21.08	.79	.49	23.19	.90
.70	.1351	.37	22.09	.80	.51	24.22
.75	.1333	.66	.38	23.11	.83	.55
.80	.1316	.95	.68	.42	24.15	.88
.85	.1299	22.24	.98	.72	.46	25.21
.90	.1282	.53	23.28	24.03	.78	.53
.95	.1266	.82	.58	.34	25.10	.86

Yards per lb.	Reed. Decimal Equiv'nt	70	72	74	76	78	80
		Numbers.					
3.00	.1667	20.22	.79	.37	.95	.53	23.11
.05	.1639	.56	21.14	.73	22.32	.90	.49
.10	.1613	.89	.49	22.09	.68	23.28	.88
.15	.1587	21.23	.83	.44	23.05	.66	24.26
.20	.1562	.57	22.18	.80	.42	24.03	.65
.25	.1538	.90	.53	23.16	.78	.41	25.03
.30	.1515	22.24	.87	.51	24.15	.78	.42
.35	.1493	.58	23.22	.87	.51	25.16	.80
.40	.1471	.91	.57	24.22	.88	.53	26.19
.45	.1449	23.25	.92	.58	25.24	.91	.57
.50	.1429	.59	24.26	.94	.61	26.28	.96
.55	.1408	.93	.61	25.29	.98	.66	27.34
.60	.1389	24.26	.96	.65	26.34	27.04	.73
.65	.1370	.60	25.30	26.01	.71	.41	28.11
.70	.1351	.94	.65	.36	27.07	.79	.50
.75	.1333	25.27	26.00	.72	.44	28.16	.89
.80	.1316	.61	.34	27.07	.81	.54	29.27
.85	.1299	.95	.69	.43	28.17	.91	.66
.90	.1282	26.28	27.04	.79	.54	29.29	30.04
.95	.1266	.62	.38	28.14	.90	.67	.43

Yards per lb.	Reed. Decimal Equivalent	82	84	86	88	90
		Numbers.				
3.00	.1667	.68	24.26	.84	25.42	26.00
.05	.1639	4.08	.67	25.25	.84	.43
.10	.1613	.47	25.07	.67	26.27	.86
.15	.1587	.87	.48	26.08	.69	27.30
.20	.1562	25.26	.88	.50	27.11	.73
.25	.1538	.66	26.28	.91	.54	28.16
.30	.1515	26.05	.69	27.32	.96	.60
.35	.1493	.45	27.09	.74	28.38	29.03
.40	.1471	.84	.50	28.15	.81	.46
.45	.1449	27.24	.90	.57	29.23	.90
.50	.1429	.63	28.31	.98	.66	30.33
.55	.1408	28.03	.71	29.40	30.08	.76
.60	.1389	.42	29.12	.81	.50	31.20
.65	.1370	.82	.52	30.22	.93	.63
.70	.1351	29.21	.93	.64	31.35	32.06
.75	.1333	.61	30.33	31.05	.77	.50
.80	.1316	30.00	.73	.47	32.20	.93
.85	.1299	.30	31.14	.88	.62	33.36
.90	.1282	.79	.54	32.29	33.05	.80
.95	.1266	31.19	.95	.71	.47	34.23

Yards per lb.	Reed. Decimal Equivalent	20	22	24	26	28
		Numbers.				
4.00	.1250	7.04	.47	.24	10.01	.78
.05	.1235	7.81	8.57	9.35	10.14	10.92
.10	.1220	.89	.68	.47	.26	11.05
.15	.1205	.99	.79	.59	.39	.18
.20	.1190	8.08	.89	.70	.51	.32
.25	.1176	.18	9.00	.82	.64	.45
.30	.1163	.28	.10	.93	.76	.59
.35	.1149	.37	.22	10.05	.89	.72
.40	.1136	.47	.33	.16	11.01	.80
.45	.1124	.57	.42	.28	.14	.99
.50	.1111	.66	.53	.39	.26	12.13
.55	.1099	.76	.63	.51	.39	.26
.60	.1087	.85	.74	.62	.51	.40
.65	.1075	.95	.85	.74	.64	.53
.70	.1084	9.05	.95	.86	.76	.67
.75	.1053	.14	10.06	.97	.89	.80
.80	.1042	.24	.16	11.09	12.01	.94
.85	.1031	.34	.27	.20	.14	13.07
.90	.1020	.43	.38	.32	.26	.21
.95	.1010	.53	.48	.43	.39	.34

Yards per lb.	Reed. Decimal Equivalent	30	32	34	36	38
		Numbers.				
4.00	.1250	.55	.32	13.09	.86	.63
.05	.1235	11.69	12.47	13.26	14.03	14.82
.10	.1220	.84	.63	.42	.21	15.00
.15	.1205	.98	.78	.58	.38	.18
.20	.1190	12.13	.94	.75	.55	.36
.25	.1176	.27	13.09	.91	.73	.55
.30	.1163	.42	.24	14.07	.90	.73
.35	.1149	.56	.40	.24	15.07	.91
.40	.1136	.71	.55	.40	.25	16.10
.45	.1124	.85	.71	.57	.42	.28
.50	.1111	13.00	.86	.73	.60	.46
.55	.1099	.14	14.02	.89	.77	.65
.60	.1087	.28	.17	15.06	.94	.83
.65	.1075	.43	.32	.22	16.12	17.01
.70	.1084	.57	.48	.38	.29	.19
.75	.1053	.72	.63	.55	.46	.38
.80	.1042	.86	.79	.71	.64	.56
.85	.1031	14.01	.94	.87	.81	.74
.90	.1020	.15	15.09	16.04	.98	.93
.95	.1010	.30	.25	.20	17.16	18.11

	Reed.	40	42	44	46	48
Yards per lb.	Decimal Equivalent	Numbers.				
4.00	.1250	.40	16.17	.94	.48	
.05	.1235	15.60	16.38	17.15	17.94	18.72
.10	.1220	.79	5.82	.37	18.16	.95
.15	.1205	.98	7.85	.58	.38	19.18
.20	.1190	16.17	9.87	.79	.60	.41
.25	.1176	.37	17.18	18.00	.83	.64
.30	.1163	.56	3.91	.21	19.05	.87
.35	.1149	.75	5.94	.43	.27	20.10
.40	.1136	.94	7.96	.64	.49	.33
.45	.1124	17.14	.99	.88	.71	.56
.50	.1111	.33	18.20	19.06	.93	.80
.55	.1099	.52	.40	.27	20.15	21.03
.60	.1087	.71	.60	.48	.37	.26
.65	.1075	.91	.80	.70	.59	.49
.70	.1084	18.10	19.00	.91	.82	.72
.75	.1053	.29	.21	20.12	21.04	.95
.80	.1042	.48	.41	.33	.26	22.18
.85	.1031	.68	.61	.54	.48	.41
.90	.1020	.87	.81	.76	.70	.64
.95	.1010	19.06	20.02	.97	.92	.88

	Reed.	50	52	54	56	58
Yards per lb.	Decimal Equivalent	Numbers.				
4.00	.1250	.26	20.03	.80	.57	.34
.05	.1235	19.50	20.28	21.06	21.84	22.62
.10	.1220	.74	.53	.32	22.10	.90
.15	.1205	.98	.78	.58	.37	23.17
.20	.1190	20.22	21.03	.84	.64	.45
.25	.1176	.46	.28	22.10	.91	.73
.30	.1163	.70	.53	.36	23.18	24.01
.35	.1149	.94	.78	.62	.45	.29
.40	.1136	21.18	22.03	.88	.72	.57
.45	.1124	.42	.28	23.14	.99	.84
.50	.1111	.66	.53	.40	24.26	25.12
.55	.1099	.90	.78	.66	.53	.40
.60	.1087	22.14	23.03	.92	.80	.68
.65	.1075	.38	.28	24.18	25.07	.96
.70	.1084	.63	.53	.44	.34	26.24
.75	.1053	.87	.78	.70	.61	.52
.80	.1042	23.11	24.03	.96	.88	.80
.85	.1031	.35	.28	25.22	26.15	27.08
.90	.1020	.59	.53	.48	.42	.36
.95	.1010	.83	.78	.74	.69	.64

Yards per lb.	Reed. Decimal Equivalent	60	62	64	66	68
		Numbers.				
4.00	.1250	23.11	.88	.65	.42	26.19
.05	.1235	23.40	24.18	24.96	25.74	26.52
.10	.1220	.68	.47	25.26	26.05	.84
.15	.1205	.97	.77	.57	.37	27.17
.20	.1190	24.26	25.07	.88	.69	.50
.25	.1176	.55	.37	26.19	27.01	.83
.30	.1163	.84	.67	.50	.32	28.15
.35	.1149	25.13	.97	.80	.64	.48
.40	.1136	.42	26.27	27.11	.96	.81
.45	.1124	.71	.56	.42	28.28	29.13
.50	.1111	26.00	.86	.73	.60	.46
.55	.1099	.28	27.16	28.04	.91	.79
.60	.1087	.57	.46	.35	29.23	30.12
.65	.1075	.86	.76	.65	.55	.45
.70	.1084	27.05	28.06	.96	.87	.77
.75	.1053	.44	.36	29.27	30.19	31.10
.80	.1042	.73	.65	.58	.50	.43
.85	.1031	28.02	.95	.89	.82	.75
.90	.1020	.31	29.25	30.19	31.14	32.08
.95	.1010	.60	.55	.50	.46	.41

Yards per lb.	Reed. Decimal Equiv'nt	70	72	74	76	78	80
		Numbers.					
4.00	.1250	.96	.73	.50	29.27	30.04	.81
.05	.1235	27.30	28.08	28.86	29.64	30.42	31.20
.10	.1220	.63	.42	29.21	30.00	.79	.58
.15	.1205	.97	.77	.57	.37	31.17	.97
.20	.1190	28.31	29.12	.92	.73	.54	32.35
.25	.1176	.64	.46	30.28	31.10	.92	.74
.30	.1163	.98	.81	.64	.47	32.29	33.12
.35	.1149	29.32	30.16	.99	.83	.67	.51
.40	.1136	.65	.50	31.35	32.20	33.05	.89
.45	.1124	.99	.85	.71	.56	.42	34.28
.50	.1111	30.33	31.20	32.06	.93	.80	.66
.55	.1099	.67	.54	.42	33.30	34.17	35.05
.60	.1087	31.00	.89	.78	.66	.55	.43
.65	.1075	.34	32.24	33.13	34.03	.92	.82
.70	.1084	.68	.58	.49	.39	35.30	
.75	.1053	32.01	.93	.84	.76	.67	
.80	.1042	.35	33.28	34.20	35.13	36.05	
.85	.1031	.69	.62	.56	.49	.43	
.90	.1020	33.03	.97	.91	.86	.80	
.95	.1010	.36	34.32	35.27	36.22	37.18	

	Reed.	82	84	86	88	90
Yards per lb.	Decimal Equivalent	Numbers.				
4.00	.1250	31.58	32.35	33.12	33.89	34.66
.05	.1235	.98	.76	.54	34.32	35.10
.10	.1220	32.37	33.16	.95	.74	.53
.15	.1205	.77	.57	34.36	35.16	.96
.20	.1190	33.16	.97	.78	.59	36.40
.25	.1176	.56	34.37	35.19	36.01	.83
.30	.1163	.95	.78	.61	.43	37.26
.35	.1149	34.35	35.18	36.02	.86	.70
.40	.1136	.74	.59	.43	37.28	38.13
.45	.1124	35.13	.99	.85	.71	.56
.50	.1111	.53	36.40	37.26	38.13	39.00
.55	.1099	.92	.80	.68	.55	.43
.60	.1087	36.32	37.21	38.09	.98	.86
.65	.1075	.71	.61	.51	39.40	40.30
.70	.1084					
.75	.1053					
.80	.1042					
.85	.1031					
.90	.1020					
.95	.1010					

	Reed.	20	22	24	26	28
Yards per lb.	Decimal Equivalent	Numbers.				
5.00	.1000	6.30	5.93	.55	.51	.48
.05	.9901	.72	.69	.66	.64	.61
.10	.9804	.82	.80	.78	.76	.75
.15	.9709	.91	.91	.90	.89	.88
.20	.9615	10.01	11.01	12.01	13.02	14.02
.25	.9524	1.11	.12	.13	.14	.15
.30	.9434	.20	.22	.24	.27	.29
.35	.9346	.30	.33	.36	.39	.42
.40	.9259	.40	.44	.47	.52	.55
.45	.9174	.49	.54	.59	.67	.69
.50	.9091	.59	.65	.70	.80	.82
.55	.9009	.68	.75	.82	.92	.96
.60	.8929	.78	.86	.93	14.05	15.09
.65	.8850	.88	.97	13.05	.17	.23
.70	.8772	.97	12.07	.17	.30	.36
.75	.8690	11.07	.18	.28	.42	.50
.80	.8621	.17	.28	.40	.55	.63
.85	.8547	.26	.39	.51	.67	.77
.90	.8479	.36	.49	.63	.77	15.90
.95	.8403	.45	.60	.75	.89	.04

	Reed.	30	32	34	36	38
Yards per lb.	Decimal Equivalent	Numbers.				
5.00	.1000	.44	.40	.37	.33	.29
.05	.9901	.58	.56	.53	.50	.47
.10	.9804	.73	.71	.69	.68	.66
.15	.9709	.87	.81	.86	.85	.84
.20	.9615	5.02	16.02	17.02	18.02	19.02
.25	.9524	.16	.17	.18	.20	.21
.30	.9434	.31	.33	.25	.32	.39
.35	.9346	.45	.47	.41	.54	.57
.40	.9259	.60	.63	.58	.72	.76
.45	.9174	.74	.78	.74	.89	.94
.50	.9091	.88	.93	.90	19.06	2.01
.55	.9009	16.03	17.09	18.07	.24	.30
.60	.8929	.17	.24	.23	.41	.49
.65	.8850	.32	.40	.39	.58	.67
.70	.8772	.46	.55	.56	.76	.85
.75	.8690	.61	.70	.72	.93	21.04
.80	.8621	.75	.86	.89	20.10	.22
.85	.8547	.90	18.01	19.05	.28	.40
.90	.8479	17.04	.18	.31	.45	.59
.95	.8403	.18	.33	.48	.62	.77

	Reed.	40	42	44	46	48
Yards per lb.	Decimal Equivalent	Numbers.				
5.00	.1000	.26	.22	21.18	22.14	23.11
.05	.9901	.45	.42	.39	.37	.34
.10	.9804	.64	.62	.60	.59	.57
.15	.9709	.83	.82	.81	.81	.80
.20	.9615	20.03	21.03	22.03	23.03	24.03
.25	.9524	.22	.23	.24	.25	.26
.30	.9434	.41	.43	.45	.47	.49
.35	.9346	.60	.63	.66	.69	24.72
.40	.9259	.80	.84	.87	.92	.96
.45	.9174	.99	22.04	23.09	24.14	25.19
.50	.9091	21.18	.24	.30	.36	.42
.55	.9009	.37	.44	.51	.58	.65
.60	.8929	.57	.64	.72	.80	.88
.65	.8850	.76	.85	.93	25.02	26.11
.70	.8772	.95	23.05	24.15	.24	.34
.75	.8690	22.14	.25	.36	.47	.57
.80	.8621	.34	.45	.27	.69	.80
.85	.8547	.53	.66	.78	.91	27.04
.90	.8475	.72	.86	.99	26.13	.27
.95	.8403	.91	24.06	25.21	.34	.50

Yards per lb.	Reed. Decimal Equivalent	50	52	54	56	58
		Numbers.				
5.00	.1000	24.07	25.03	26.00	.96	.92
.05	.9901	.31	.28	.26	27.23	28.20
.10	.9804	.55	.53	.52	.50	.47
.15	.9709	.79	.78	.78	.77	.75
.20	.9615	25.03	26.03	27.04	28.04	29.03
.25	.9524	.27	.28	.30	.31	.31
.30	.9434	.51	.54	.56	.58	.59
.35	.9346	.75	.79	.82	.85	.87
.40	.9259	.99	27.04	28.08	29.12	30.15
.45	.9174	26.23	.29	.34	.39	.43
.50	.9091	.47	.54	.60	.66	.71
.55	.9009	.71	.79	.86	.93	.99
.60	.8929	.95	28.04	29.12	30.19	31.27
.65	.8850	27.19	.29	.38	.46	.55
.70	.8772	.43	.54	.64	.73	.83
.75	.8690	.67	.79	.90	31.00	32.10
.80	.8621	.91	29.04	30.16	.27	.39
.85	.8547	28.15	.29	.42	.54	.67
.90	.8475	.39	.54	.68	.81	.95
.95	.8403	.63	.79	.94	32.08	33.23

Yards per lb.	Reed. Decimal Equivalent	60	62	64	66	68
		Numbers.				
5.00	.1000	.89	.85	.81	.77	.74
.05	.9901	29.17	30.15	31.12	32.09	33.06
.10	.9804	.46	.45	.43	.41	.39
.15	.9709	.75	.74	.74	.73	.72
.20	.9615	30.04	31.04	32.04	33.05	34.05
.25	.9524	.33	.34	.35	.36	.37
.30	.9434	.62	.64	.66	.68	.70
.35	.9346	.91	.94	.97	34.00	35.03
.40	.9259	31.20	32.24	33.28	.32	.36
.45	.9174	.49	.53	.58	.63	.68
.50	.9091	.77	.83	.89	.95	36.01
.55	.9009	32.06	33.13	34.20	35.27	.34
.60	.8929	.35	.43	.51	.59	.67
.65	.8850	.64	.73	.82	.91	.99
.70	.8772	.93	34.03	35.13	36.22	37.32
.75	.8690	33.22	.33	.43	.54	.65
.80	.8621	.51	.62	.74	.86	.98
.85	.8547	.80	.92	36.05	37.18	38.30
.90	.8475	34.09	35.22	.36	.49	.63
.95	.8403	.38	.52	.67	.81	.96

Yards per lb.	Reed. Decimal Equivalent	70	72	74	76	78
		Numbers.				
5.00	.1000	.70	.66	.63	.59	.55
.05	.9901	34.04	35.01	.98	.95	.93
.10	.9804	.37	.36	36.34	37.32	38.30
.15	.9709	.71	.70	.69	.69	.68
.20	.9615	35.05	36.05	37.05	38.05	39.05
.25	.9524	.39	.40	.41	.42	.43
.30	.9434	.72	.74	.76	.78	.81
.35	.9346	36.06	37.09	38.12	39.15	40.18
.40	.9259	.40	.44	.48	.52	.56
.45	.9174	.73	.78	.83	.88	.93
.50	.9091	37.07	38.13	39.19	40.25	41.31
.55	.9009	.41	.48	.55	.61	.68
.60	.8929	.74	.82	.90	.98	42.06
.65	.8850	38.08	39.17	40.26	41.35	.43
.70	.8772	.42	.52	.61	.71	.81
.75	.8690	.76	.86	.97	42.08	43.19
.80	.8621	39.09	40.21	41.33	.44	.56
.85	.8547	.43	.56	.68	.81	.93
.90	.8475	.77	.90	42.04	43.18	44.31
.95	.8403	40.10	41.25	.40	.54	.69

Yards per lb.	Reed. Decimal Equivalent	20	22	24	26	28
		Numbers.				
6.00	.8333	.55	.71	.86	15.02	.17
.05	.8264	.65	.81	.98	.14	.31
.10	.8197	.74	.92	14.09	.27	.44
.15	.8130	.84	13.02	.21	.39	.58
.20	.8065	.94	.13	.32	.52	.71
.25	.8000	12.03	.24	.44	.64	.85
.30	.7937	.13	.34	.56	.77	.98
.35	.7874	.23	.45	.67	.89	17.12
.40	.7812	.32	.55	.79	16.02	.25
.45	.7752	.42	.66	.90	.14	.39
.50	.7692	.51	.77	15.02	.27	.52
.55	.7634	.61	.87	.13	.39	.66
.60	.7576	.71	.98	.25	.52	.79
.65	.7519	.80	14.08	.36	.65	.93
.70	.7463	.90	.19	.48	.77	18.06
.75	.7407	13.00	.30	.60	.90	.20
.80	.7353	.09	.40	.71	17.02	.33
.85	.7299	.19	.51	.83	.15	.47
.90	.7246	.28	.61	.94	.27	.60
.95	.7194	.38	.72	16.06	.40	.73

	Reed.	30	32	34	36	38
Yards per lb.	Decimal Equivalent	Numbers.				
6.00	.8333	3.34	.48	.64	.80	.95
.05	.8264	4.78	.64	.80	.97	22.13
.10	.8197	6.22	.79	.97	21.14	.32
.15	.8130	7.67	.95	20.13	.32	.50
.20	.8065	9.11	19.10	.30	.49	.68
.25	.8000	18.05	.25	.46	.66	.87
.30	.7937	2.00	.41	.62	.84	23.05
.35	.7874	3.45	.56	.79	22.01	.23
.40	.7812	4.89	.72	.95	.18	.42
.45	.7752	6.34	.87	21.11	.36	.60
.50	.7692	7.78	20.02	.28	.53	.78
.55	.7634	9.22	.18	.44	.70	.96
.60	.7576	19.06	.33	.60	.88	24.15
.65	.7519	2.11	.49	.77	23.05	.33
.70	.7463	3.56	.64	.93	.22	.51
.75	.7407	5.00	.79	22.10	.40	.70
.80	.7353	6.45	.95	.26	.57	.88
.85	.7299	7.89	21.10	.42	.74	25.09
.90	.7246	9.34	.26	.59	.92	.25
.95	.7194	20.07	.41	.75	24.09	.43

	Reed.	40	42	44	46	48
Yards per lb.	Decimal Equivalent	Numbers				
6.00	.8333	23.11	.26	.42	.56	.73
.05	.8264	.30	.46	.63	.79	.96
.10	.8197	.49	.67	.84	27.01	28.19
.15	.8130	.68	.87	26.05	.23	.42
.20	.8065	.88	25.07	.27	.45	.68
.25	.8000	24.07	.27	.48	.67	.89
.30	.7937	.26	.48	.69	.89	29.12
.35	.7874	.46	.68	.90	28.11	.35
.40	.7812	.65	.88	27.11	.34	.58
.45	.7752	.84	26.08	.32	.56	.81
.50	.7692	25.03	.28	.54	.78	30.04
.55	.7634	.23	.49	.75	29.00	.27
.60	.7576	.42	.69	.96	.22	.50
.65	.7519	.61	.89	28.17	.44	.73
.70	.7463	.80	27.09	.38	.66	.97
.75	.7407	26.00	.30	.59	.89	31.20
.80	.7353	.19	.50	.81	30.11	.43
.85	.7299	.38	.70	29.02	.33	.66
.90	.7246	.57	.90	.23	.56	.89
.95	.7194	.77	28.10	.44	.78	32.12

Reed.		50	52	54	56	58
Yards per lb.	Decimal Equivalent	Numbers.				
6.00	.8333	.87	30.04	31.20	.35	.51
.05	.8264	29.11	.29	.46	.62	.79
.10	.8197	.37	.54	.72	.89	34.07
.15	.8130	.61	.79	.98	33.16	.35
.20	.8065	.85	31.04	32.24	.43	.62
.25	.8000	30.09	.29	.50	.70	.90
.30	.7937	.33	.54	.76	.97	35.18
.35	.7874	.57	.79	33.02	34.24	.46
.40	.7812	.80	32.04	.28	.51	.74
.45	.7752	31.05	.29	.54	.78	36.02
.50	.7692	.29	.54	.80	35.05	.30
.55	.7634	.54	.79	34.06	.32	.58
.60	.7576	.79	33.05	.32	.59	.86
.65	.7519	32.03	.30	.58	.86	37.14
.70	.7463	.27	.55	.84	36.13	.42
.75	.7407	.51	.80	35.10	.40	.70
.80	.7353	.75	34.05	.36	.67	.98
.85	.7299	.99	.30	.62	.94	38.25
.90	.7246	33.23	.55	.88	37.21	.53
.95	.7194	.47	.80	36.14	.47	.81

Reed.		60	62	64	66	68
Yards per lb.	Decimal Equivalent	Numbers.				
6.00	.8333	.66	.82	.97	38.13	39.29
.05	.8264	.95	36.12	37.28	.45	.61
.10	.8197	35.24	.42	.59	.77	.94
.15	.8130	.53	.71	.90	39.08	40.27
.20	.8065	.82	37.01	38.21	.40	.60
.25	.8000	36.11	.31	.52	.72	.92
.30	.7937	.40	.61	.82	40.04	41.25
.35	.7874	.69	.91	39.13	.35	.58
.40	.7812	.97	38.21	.44	.67	.90
.45	.7752	37.26	.51	.75	.99	42.23
.50	.7692	.55	.80	40.06	41.31	.56
.55	.7634	.84	39.10	.36	.63	
.60	.7576	38.14	.40	.67	.94	
.65	.7519	.42	.70	.98	42.26	
.70	.7463	.71	40.00	41.29	.58	
.75	.7407	39.00	.30	.60	.90	
.80	.7353	.29	.60	.90	43.21	
.85	.7299	.57	.89	42.21	.53	
.90	.7246	.86	41.19	.52	.85	
.95	.7194	40.15	.49	.83	44.17	

Yards per lb.	Reed. Decimal Equivalent	70	72	74	76	78
		Numbers.				
6.00	.8333	.44	.60	.75	.91	45.06
.05	.8264	.78	.94	43.11	44.27	.43
.10	.8197	41.12	42.29	.46	.64	.81
.15	.8130	.45	.65	.82	45.01	46.19
.20	.8065	.79	.99	44.18	.37	.57
.25	.8000	42.13	43.34	.53	.74	.94
.30	.7937	.46	.69	.89	46.10	47.32
.35	.7874	.80	44.03	45.25	.47	.69
.40	.7812	43.14	.38	.60	.84	48.07
.45	.7752	.47	.73	.96	47.20	.44
.50	.7692	.81	45.07	46.32	.57	.82
.55	.7634					
.60	.7576					
.65	.7519					
.70	.7463					
.75	.7407					
.80	.7353					
.85	.7299					
.90	.7246					
.95	.7194					

Yards per lb.	Reed. Decimal Equivalent	20	22	24	26	28
		Numbers.				
7.00	.7143	.48	.83	.13	.52	.87
.05	.7092	13.57	14.93	16.29	16.77	18.06
.10	.7042	.67	15.04	.40	·90	.20
.15	.6993	.77	.14	.52	17.02	.33
.20	.6944	.86	.25	.64	.15	.47
.25	.6897	.96	.35	.75	.27	.60
.30	.6849	14.05	.46	.87	.40	.73
.35	.6803	.15	.57	.98	.52	.87
.40	.6757	.25	.67	17.10	.65	19.00
.45	.6711	.34	.78	.21	.77	.14
.50	.6667	.44	.88	.33	.90	.27
.55	.6623	.54	.99	.44	18.02	.41
.60	.6579	.63	16.10	.56	.15	.54
.65	.6536	.73	.20	.68	.27	.68
.70	.6494	.83	.31	.79	.40	.81
.75	.6452	.92	.41	.91	.52	.95
.80	.6410	15.02	.52	18.02	.65	20.08
.85	.6369	.11	.63	.14	.77	.22
.90	.6329	.21	.73	.25	.90	.35
.95	.6289	.31	.84	.37	19.02	.49

Yards per lb.	Reed. Decimal Equivalent	30	32	34	36	38
		Numbers.				
7.00	.7143	2.23	.56	.91	.26	.61
.05	.7092	19.35	21.72	23.08	24.44	25.79
.10	.7042	.50	.87	.24	.60	.98
.15	.6993	.64	22.03	.41	.78	26.16
.20	.6944	.78	.18	.57	.96	.34
.25	.6897	.93	.33	.73	25.13	.53
.30	.6849	20.07	.49	.90	.30	.71
.35	.6803	.22	.64	24.06	.48	.89
.40	.6757	.36	.80	.23	.65	27.07
.45	.6711	.51	.95	.39	.82	.26
.50	.6667	.65	23.10	.65	26.00	.44
.55	.6623	.80	.26	.72	.17	.62
.60	.6579	.94	.41	.88	.34	.81
.65	.6536	21.08	.57	25.04	.52	.99
.70	.6494	.23	.73	.20	.70	28.17
.75	.6452	.37	.88	.37	.86	.36
.80	.6410	.52	24.03	.53	27.04	.54
.85	.6369	.66	.19	.70	.21	.72
.90	.6329	.81	.34	.86	.38	.90
.95	.6289	.95	.49	26.02	.56	29.09

Yards per lb.	Reed. Decimal Equivalent	40	42	44	46	48
		Numbers.				
7.00	.7143	.96	.31	.65	31.00	.35
.05	.7092	27.15	28.51	29.87	31.23	32.58
.10	.7042	.34	.71	30.08	.45	.81
.15	.6993	.54	.91	.29	.67	33.05
.20	.6944	.73	29.12	.50	.89	.28
.25	.6897	.92	.32	30.71	32.11	.51
.30	.6849	28.11	.52	.92	.33	.74
.35	.6803	.31	.72	31.14	.55	.97
.40	.6757	.50	.93	.35	.78	34.20
.45	.6711	.69	30.13	.56	33.00	.43
.50	.6667	.89	.33	.77	.22	.66
.55	.6623	29.08	.53	.98	.44	.89
.60	.6579	.27	.73	32.20	.66	35.13
.65	.6536	.46	.94	.41	.88	.36
.70	.6494	.66	31.15	.62	34.10	.59
.75	.6452	.85	.34	.83	.33	.82
.80	.6410	30.04	.54	33.04	.55	36.05
.85	.6369	.23	.75	.25	.77	.28
.90	.6329	.43	.95	.47	.99	.51
.95	.6289	.62	32.15	.68	35.21	.74

	Reed.	50	52	54	56	58
Yards per lb.	Decimal Equivalent	Numbers.				
7.00	.7143	.71	35.05	.40	.74	39.09
.05	.7092	33.94	35 30	36.66	38.01	39.37
.10	.7042	34.18	.55	.92	.28	.65
.15	.6993	.42	.80	37.18	.55	.93
.20	.6944	.66	36.05	.44	.82	40.22
.25	.6897	.90	.30	.70	39.09	.49
.30	.6849	35.14	.55	.96	.36	.77
.35	.6803	.39	.80	38.22	.63	41.05
.40	.6757	.63	37.05	.48	.90	.33
.45	.6711	.87	.30	.74	40.17	.61
.50	.6667	36.11	.55	39.00	.44	.89
.55	.6623	.35	.80	.26	.71	42.16
.60	.6579	.59	38.05	.52	.98	.44
.65	.6536	.83	.30	.78	44.25	.72
.70	.6494	37.07	.55	40.04	.52	45.00
.75	.6452	.31	.80	.30	.79	.28
.80	.6410	.55	39.05	.56	42.06	.56
.85	.6369	.79	.30	.82	.33	.84
.90	.6329	38.03	.55	41.08	.60	44.12
.95	.6289	.27	.80	.34	.87	.40

	Reed.	60	62	64	66	68
Yards per lb.	Decimal Equivalent	Numbers.				
7.00	.7143	.44	.79	43.14	.49	
.05	.7092	40.73	42.09	43.45	44.80	
.10	.7042	41.02	.39	.75	45.12	
.15	.6993	.31	.68	44.06	.44	
.20	.6944	.60	.98	.37	.76	
.25	.6897	.89	43.28	.68	46.07	
.30	.6849	42.17	.58	.99	.39	
.35	.6803	.46	.88	45.29	.71	
.40	.6757	.75	44.18	.60	47.03	
.45	.6711	43.04	.48	.91	.35	
.50	.6667	.33	.77	46.22	.66	
.55	.6623	.62	45.07	.53	.98	
.60	.6579	.91	.37	.84	48.29	
.65	.6536	44.20	.67	47.14	.61	
.70	.6494	.49	.97	.45	.92	
.75	.6452	.77	46.27	.76	49.21	
.80	.6410	45.06	.57	48.07	.52	
.85	.6369	.35	.86	.38	.84	
.90	.6329	.64	47.16	.68	50.11	
.95	.6289	.93	.46	.99	.43	

	Reed.	20	22	24	26	28
Yards per lb.	Decimal Equivalent	Numbers.				
8.00	.6250	.40	.94	.48	.15	.62
.05	.6211	.50	17.05	.60	.27	.76
.10	.6173	.60	.16	.72	.40	.89
.15	.6135	.69	.26	.83	.52	21.03
.20	.6098	.79	.37	.95	.65	.16
.25	.6061	.88	.47	19.06	.78	.30
.30	.6024	.98	.58	.18	.90	.43
.35	.5988	16.08	.69	.29	20.03	.57
.40	.5952	.17	.79	.41	.15	.70
.45	.5917	.27	.90	.52	.28	.84
.50	.5882	.37	18.00	.64	.40	.97

	Reed.	30	32	34	36	38
Yards per lb.	Decimal Equivalent	Numbers.				
8.00	.6250	22.70	.65	.19	.73	.27
.05	.6211	.24	.80	.35	.90	.45
.10	.6173	.38	.96	.52	28.08	.64
.15	.6135	.53	25.11	.68	.25	.82
.20	.6098	.67	.26	.84	.42	30.00
.25	.6061	.82	.42	27.01	.60	.19
.30	.6024	.96	.57	.17	.77	.37
.35	.5988	23.11	.73	.33	.94	.55
.40	.5952	.25	.88	.50	29.12	.73
.45	.5917	.40				
.50	.5882	.54				

Yards per lb.	Decimal Equivalent	Reed. 40	42	44	46	48
		Numbers.				
8.00	.6250	.81	.35	.89	.43	.97
.05	.6211	31.00	.55	34.10	.65	37.21
.10	.6173	.20	.76	.32	.88	.44
.15	.6135	.39	.96	.53	36.10	.67
.20	.6098	.58	33.16	.74	.32	.90
.25	.6061	.77	.36	.95	.54	38.13
.30	.6024	.97	.57	35.16	.76	.36
.35	.5988	32.16	.77	.38	.98	.59
.40	.5952	.35	.97			
.45	.5917					
.50	.5882					

Yards per lb.	Decimal Equivalent	Reed. 50	52	54	56	58
		Numbers.				
8.00	.6250	.52	40.06	.60	43.14	.68
.05	.6211	.76	.31	.86	.41	.96
.10	.6173	39.00	.56	42.12	.68	45.24
.15	.6135	.24	.81	.38	.95	.52
.20	.6098	.48	41.06	.64	44.22	.81
.25	.6061	.72	.31	.90		
.30	.6024	.96	.56	43.16		
.35	.5988	40.20	.81	.42		
.40	.5952					
.45	.5917					
.50	.5882					

Yards per lb.	Decimal Equivalent	Reed. 60	62	64	66
		Numbers.			
8.00	.6250	46.22	.76	49.30	.74
.05	.6211	.51	48.06	.61	51.06
.10	.6173	.80	.36	.92	.37
.15	.6135	47.09	.66	50.23	.69
.20	.6098	.37	.96	.54	52.01
.25	.6061				
.30	.6024				
.35	.5988				
.40	.5952				
.45	.5917				
.50	.5882				

THE SCHAER PATENT YARN SCALE, TEMPLATE, AND CLOTH CALCULATOR.

These instruments are devices intended to simplify the process of getting at the number of any given specimen of yarn, the number of yards per pound, and number of yarn in a sample of woven cloth, or figuring what yarns will be needed to make any given kind of cloth desired.

Every Treasurer, Agent, and Superintendent of a mill ought to have a set of these instruments, to enable him to quickly and accurately estimate the cost of a given sample.

The yarn scale is so graduated that in using any sample of 120 yards of yarn in the pan, the graduations on the beam indicate at once the number of the yarn. The same result is obtained with 480 yards, 60 and 30 yards, by using the proportionate weights.

The template is designed to be used in cutting a certain sized pattern from any given piece of cloth which will correspond to a certain number of yards of yarn, and this piece of cloth after being cut out, is used on the scale, and the average number of yarn in its make up is at once determined, the same as by weighing the yarn itself before woven. Also, cutting a piece of cloth by the graduations showing width in inches, the yards per pound are at once obtained by weighing the sample on the scale.

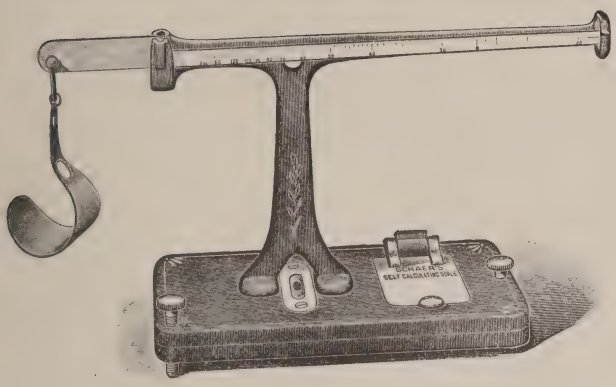
The cloth calculator is a special slide rule by the use of which, when any three of these elements, namely, yards per pound, average number of yarn, width of cloth in inches, and average count are given, by setting the slide rule to correspond therewith, the fourth of these elements is at once shown on the rule.

The inventor of these instruments is Mr. Arnold Schaer, Superintendent of the Warren Mfg. Co., Warren, R. I., than whom there is probably no one more expert in the figuring and dissecting of various kinds of cloth.

The yarn scale and template are of advantage to anyone connected with cotton mill management having occasion to obtain the number of yarn in any sample, either of yarn or cloth.

The price of a complete set of the above instruments is $60.

Yarn Scale, with glass case	$25.00
Cloth Calculator, with case	25.00
Template	10.00



DIRECTIONS FOR USING SCHAER'S PATENT YARN SCALE AND TEMPLATE.

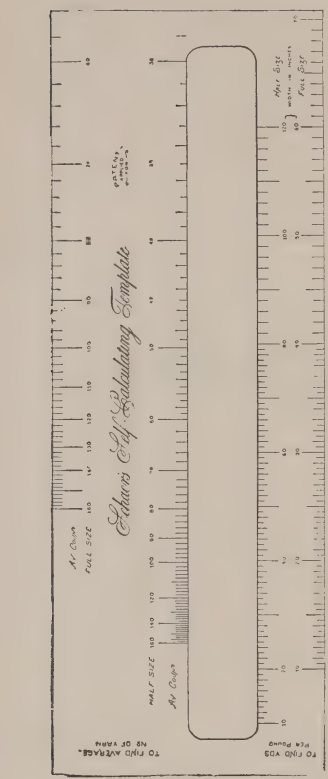
Problem No. 1.—To find the number of cotton yarns.

Rule.—Reel off 120 yards of the yarn to be tested. Balance the scale with weight No. 1, and the reading on the scale indicates the number of yarn.

For numbers coarser than 20 use weight No. 10, and point off one figure on the reading, i. e. if 40 is shown on the scale the yarn is No. 4; or take only half length or 60 yards and weigh with weight 1, dividing reading by two.

Where a smaller quantity of yarn is to be tested, use weight No. 1-2 for 60 yards and weight No. 1-4 for 30 yards, for yarns down to No. 20. Coarser than No. 20, weight No. 5 for 60 yards. No. 2 1-2 for 30 yards, pointing off one figure as with weight No. 10 above.

To get an average from several bobbins on Nos. 20 or finer, five samples of 120 yards each can be used with weight No. 5, or 10 with weight No. 10.



PROBLEM No. 2.—To find average number of yarn in cotton cloth.

RULE.—Use the self-calculating template which is graded to represent a full sized sample of cloth or 120 yards of yarn. Cut a piece of cloth to be tested the full size of the template, with a length measured by the upper scale of the template corresponding to the average count. For instance, if the cloth figured 80 x 80 or 60 x 100, the cloth should be cut of a length equal to the distance from the left hand edge of the template to the figure 80 on the upper scale. Put this piece of cloth in the yarn scale and the reading with weight No. 1 indicates the average number of yarn.

For a small sample of cloth, cut the full width of the template as before, but measure the length from the graduation on the center line of the template and use weight No. 1-2 in the scale. For a quarter size sample use the same line on the template, but cut the cloth half the width and use weight No. 1-4 on the scale.

For cloth made of yarns coarser than 20, cut the samples as above and use weights Nos. 10, 5 and 2 1-2, pointing off one figure from reading, as when weighing samples of coarse yarn.

The contraction of the yarn is allowed for on the template upon the basis of 10 per cent, which is a fair general average. On goods which contract more or less than 10 per cent, allowance to correspond can be made on the scale reading, if desired.

PROBLEM No. 3.—To find the number of yards per pound from a sample of cotton cloth.

RULE.—Use the graduations on the lower side of the template which represent the width of the cloth in inches.

For full size samples cut the cloth the full width of the template for the length, and measure the width by the bottom graduation, the figures of which represent the actual width of the goods in inches. Put this sample in the yarn scale, using

weight No. 1 and point off one place on the reading, i. e. if reading is 50 the goods are 5 yards per pound.

For half size sample use graduation marked "Half-size sample," and in the scale use weight No. 1-2. For quarter size sample, cut half the width of the template and use weight No. 1-4.

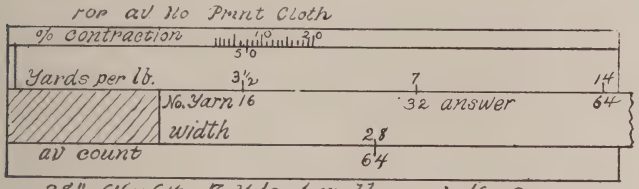
DIRECTIONS FOR USING SCHAER'S PATENT CLOTH CALCULATOR.

The graduations on this device represent four distinct elements, namely:—Yards per pound; average number of yarn; width of cloth in inches and average count of the warp and filling yarn; any three of which being known, the fourth is shown at once by the Calculator.

There is in addition a graduation to show weight of 100 yards of cloth, providing the yards per pound are known, and also a percentage graduation for contraction, i. e. amount of yarn taken up in the weaving process.

The following examples illustrate method of use:—

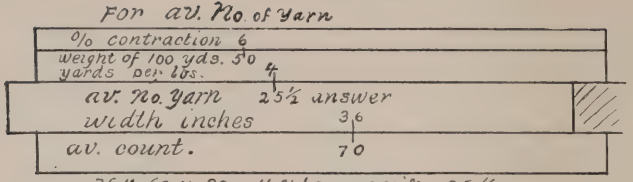
PROBLEM No. 1.—To find the average number of yarn in print cloth 28″ wide, 64x64, 7 yards per pound, estimated contraction 7 per cent.



28" 64x64. 7 Yds. per lb. = av No 32 at 7 % contraction.

RULE.—Set figure 50 at the left hand upper slide under 7, the estimated contraction: adjust the lower slide to bring together the two known quantities that are next each other, (in this instance, the width, 28″, opposite 64, the average count) and the unknown quantity is shown against the third known quantity, that is, opposite 7 yards per pound, we find 32, which is the answer for the average number of yarn.

PROBLEM No. 2.—Find the number of yards per pound in three leaf twills 36″ wide, 60x80, average number of yarn, 25.5, estimated contraction 6 per cent.

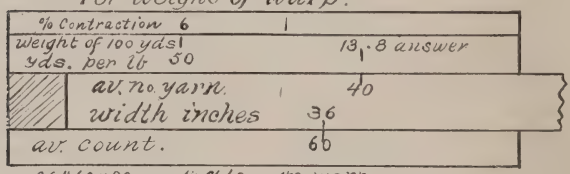

For av. No. of yarn
% contraction 6
weight of 100 yds. 50
yards per lbs. 4
av. No. yarn 25½ answer
width inches 36
av. count. 70
36" 60 x 80. 4 yds = av. No 25½
at. 6% contraction

RULE.—Set Fig. 50 on upper slide under 6, for per cent. contraction, and 36 on lower side opposite 70, average count; opposite 25.5 will be found 4, the number of yards per pound.

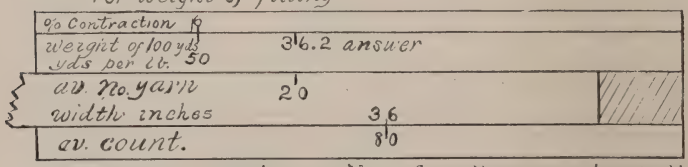
PROBLEM NO. 3.—To find the weight of 100 yards of cloth, providing the yards per pound be given, and vice versa.

RULE.—Read from the top slide by the figures which are opposite each other. For instance, if cloth is four yards to the pound, the weight of 100 yards will be 25 pounds, the reading directly above 4.

PROBLEM NO. 4.—To find the number of filling in cloth 36" wide, 60x80, four yards per pound, warp No. 40, contraction 6 per cent.


For weight of warp.
% Contraction 6
weight of 100 yds per lb 50
13.8 answer
av. No. yarn 40
width inches 36
av. count. 60
36" 60 x 80 4 yds. 40 warp
weight of 100 yds. cloth of 40's warp = 13.8

RULE.—It is necessary to first determine the weight of the warp. First ascertain the weight of 200 yards of cloth by doubling the product of Rule 3, giving twice 25 or 50 pounds. Set 36" width, opposite 60, the count of the warp, and read above No. 40 (number of the warp) 13.8 on the line showing the weight of 100 yards of cloth; this is the weight of 200 yards of warp. Deduct this from 50 and the answer is 36.2, the weight of filling required. The reason for figuring 200 yards of cloth is because either the filling or warp represents but about half the weight of the goods.


For weight of filling
% Contraction 6
weight of 100 yds yds per lb. 50
36.2 answer
av. No. yarn 20
width inches 36
av. count. 80
36" 60 x 80. 4 yds. per lb, 20's filling equals 36.2 lb

To determine the number of the filling, set 36" width, opposite 80, count of filling, and read opposite 36.2 (weight of 100 yards) 20, the number of the filling yarn required.

SPINDLES.

It has been our custom, in former editions of our catalogues, to detail the history and sales of our various spinning devices, with considerable profusion. As our sales list practically includes every mill in the country its publication would no longer serve for purposes of comparison. The Sawyer Spindle Company, for which we are sole agents, has controlled every form of successful spindle introduced in this country for over twenty-five years. This position has not been maintained without controversy and contest, but of late years the Court records have been less voluminous than formerly, it being understood that the guarantee of reputation and experience is of sufficient value to outweigh claims of irresponsible individuals. Those old in the business, will remember the fate of structures that vainly attempt competition. Even those which were allowed to run after their defeat in litigation, quickly proved their mechanical inferiority. It is not enough that a spindle should start up well, be simple in construction, or sold at a low price. *It must run well continuously*, with little power and wear. It has taken us thirty years to learn the niceties of spindle construction, and we still find need for experiment. There is no mechanical skill available, for competition which can start in on the manufacture of a special machine of any kind, without gaining its preliminary experience at the expense of poor construction. Our spindles are in universal use simply because they contain undoubted elements of efficiency. We introduced millions of Sawyer spindles, owing to their increased capacity for speed over the common, and we have supplanted nearly all the Sawyer by various forms of the Rabbeth. While Sawyer spindles are now free from patent control, no mill thinks of buying them. In like manner, no one will consider buying the earlier forms of high speed spindle when the patents expire, as our present structures are easily worth more, in comparison, than any possible difference in the cost. Our present spindle is the most expensive to manufacture of any we have ever introduced, and we take greater care than ever, to secure uniformity and perfection of detail. So far as the question of our profit is concerned, we have ever been moderate. We could have sold spindles at much higher prices, had we wished, but have preferred to make our income from large sales at reasonable figures. Owing to our conservative course, our relations with the cotton mills of this country are constantly harmonious, and our differences settled, so far as litigation is concerned.

Should a competitor appear in the spindle field, we should advise any mill desirous of trying the experiment of a new idea, to first insist on a satisfactory guarantee against infringement, backed by responsible capital, and also require a guarantee covering a sufficient term of years to insure against loss, in case of excessive wear, or disability. There are always plenty of inexperienced individuals, eager to manufacture and sell something for less than cost for a short time, if they can find a purchaser; not that they intend to lose money, but they do not, and cannot, realize the many general expenses which must be paid, outside the mere stock and labor involved. The annoyance of dealing with bankrupt concerns, or parties that change their line of business, is quite serious, when questions of repair come in. Considering the costs, risks, and proper expenses that must be deducted from the price charged, before introducers realize a profit, it will be found that the public usually gains the greater part of the benefit from any effort made to profit by its recognition.

The wonderful development of the spindle art is nowhere so well illustrated as in the patent records. The important spindle inventions have all been made since 1870, and it would seem fitting, at the end of the century, to give a brief record of the various inventors who have thought out the many possible changes in construction. Alphabetically, the more important of them list as follows, the number of their spindle patents being placed opposite to their names.

Allen, G. H.	9	Jenks, B. H.	8
Atwood, J. E.	7	Kilburn, J.	16
Bancroft, J. B.	5	Knight, G. W.	3
Birkenhead, J.	9	Logan, T. H.	5
Booth, J.	5	Mayor, T.	8
Bradley, E. E.	4	McDuffie, C. D.	1
Buttrick, C. H.	10	McMullan, J. H.	5
Carroll, E. J.	10	Morrison, W. G.	7
Carroll, W. T.	30	Northrop, J. H.	13
Chapman, C. H.	14	Pearl, O.	6
Chace, H. P.	3	Perry, W. G.	3
Day, F. M.	1	Rabbeth, F. J.	8
Draper, G.	14	Raworth, J. S.	1
Draper, G. A.	4	Rice, D. H.	6
Draper, Geo. Otis	29	Richardson, G.	9
Draper, W. F.	32	Ryon, E. H.	5
Duffy, J.	9	Sawyer, J. H.	6
Fay, R. C.	5	Scheid, A.	25
Flanders, T. B.	11	Sherman, A. R.	5
Garsed, R.	1	Stanley, J. C.	5

Goodale, B. N.	4	Taft, G. E.	5
Gray, J. R.	9	Tynan, J. E.	15
Hinchliffe, W.	4	Wattles, J. W.	19
Hopkins, A. S.	5	White, R.	4
Hussey, D.	2	Wood, A.	5
Jaquith, G.	4	Woodmancy, H. D.	10

The list given includes a few noted for reason of their prolific inventive ability rather than for their effect on the art. Most of the patentees mentioned have either had a large number of spindles actually made incorporating their ideas, or have figured in litigation as claimants of important principles.

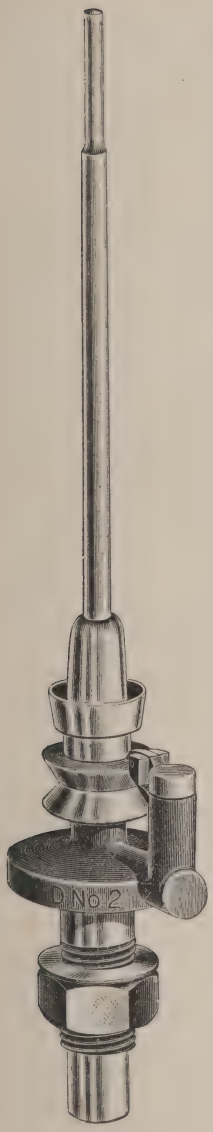
The great mass of the patents taken out by the above men are, or have been, owned by the Sawyer Spindle Co., the control of this single element, in a wide field of mechanism, necessitating the ownership of hundreds of patents within the dates mentioned. The first notable change from the old, common type, was noted in the invention of Oliver Pearl, who reduced the size of the bearings, and the weight of the structure. Sawyer added a most important element in the prolonged upper bearing, extended within the bobbin to steady the spindle within the load. Litigation between the Pearl and Sawyer patents, resulted in freeing the Sawyer from all infringement claims, its mechanical superiority over the Pearl, winning in competition for public favor, although more than a million of the latter were introduced. Other earlier types of competing structures, were the Jenks, or Excelsior, Garsed, Perry and Birkenhead. Meanwhile, the earlier Rabbeth and Atwood sleeve whorl spindle, with rigid bearings, was remodelled, so that the upper bearing entered the bobbin, similar to the Sawyer principle, and litigation ensued, in which George Draper was decided to be the inventor of this application. The invention of the Rabbeth self-centering spindle entirely upset the former standards of comparison, the principle of a yielding bearing being found to introduce a new principle in mechanics, which still lacks explanation by any accepted theory. The Court records show interference suits to establish priority for inventions of various other modifications, in which we find the names of Birkenhead, Sherman, Taft and Woodmancy, Geo. Draper, Allen, and Carroll; also, later on, the names of Wood, Chapman, Wm. F. Draper, Buttrick and Flanders, Carroll, and White. The various trade types known at the present day, owe their most important inventions to Rabbeth, Sherman, Taft and Woodmancy, Allen, and W. F. and G. A. Draper. New types, such as the Eureka, and Buttrick and Flanders spindles, were decided to be infringements, by the Courts. The Atwood silk spindle, made under agree-

ment with the Sawyer Spindle Co., also had a record of continuous litigation with competing silk structures.

Many of the most interesting types of structure have never yet been introduced for public use. Many of the apparently feasible ideas have lacked some practical element, which may be discovered at some future time. Such include structures made to run without oil, others designed to use ball, or roller bearings, various types of dead spindle, and some radical conceptions, intended to do away with one, or more, of the present elements of construction. Those who note our continued introduction of a similar type for years, do not perhaps stop to realize that we are all the time making experiments to determine possible points of superiority. Many ideas are tested, simply because they present untried ideas, when the element of value is most improbable. Success is no measure of ingenuity. Many of the brightest inventors in this line have never had one single idea adopted for practical use, while, on the other hand, many of the practical ideas were evolved by experience, rather than mental anticipation. It is possible that were the several hundred spindle inventions built for the trade, in approved form, a fair per cent. of them might find converts, and give good satisfaction in use. Such a multiplicity, however, would cause confusion to our customers, and consternation to ourselves; so that we prefer to continue the responsibility of decision as to type, for as long a time as conditions will warrant.

The spindle of to-day represents the highest development of mechanical skill to be found in textile machinery. This small and comparatively simple structure has absorbed more time, thought and money than any other single mechanical element used in the production of fabrics. Its development, with the involved experimenting, patenting, introduction and legal complications represents the expenditure of a total measured in millions. The comparatively limited field of spinning frame spindles is responsible for the greater part of this outlay, and its importance can be realized when appreciating the fact that one company has sold eighteen million of these structures in the last twenty-five years.

As is often the case with vital improvements many users of these spindles have failed at first to realize the merit of the principles involved, such lack of appreciation being evident whenever some plausibly heralded competing device is offered for their admiration. It is well perhaps, therefore, to define a few of the important characteristics of modern spindles, in order to prevent future possibilities in this line.



A spinning-frame spindle is but a revolving upright shaft, its simple duty being to carry a bobbin at high speed. That is all. When the unit thus considered, is multiplied by millions, however, the importance of the fractional savings made possible by detailed improvements is quite marked. Considered from the standpoint of wear alone, it is easily shown that a spindle that will wear twice as long as another is even more than twice as valuable, as the very fact of decreased wear proves that less power is being consumed and more satisfactory work accomplished. Wear is a good gauge for power and also vibration, other things being equal. A certain amount of wear is inevitable from moving parts but its degree is always capable of intelligent control.

The consumption of power by a spindle depends mainly on steadiness of running, good design and good workmanship so far as the structure itself is concerned. The method of use will also have a vital effect on the total amount consumed under operative conditions. Steadiness depends on the principles involved in the inventions that are now universally adopted. Good design comes from the evolution of testing and trial which gradually eliminates crudities. Good workmanship depends on the characteristics of labor and management which successful concerns must continually practice to preserve their reputation.

The best known spindle now on the market is the Draper, evolved from the preceding 49D and earlier Rabbeth types. It has been developed at the works of the Draper Co., though some of its characteristic features have been selected from other structures which are controlled by the Sawyer Spindle Company.

The elements of the Draper spindle are well known as combined and deserve technical consideration in detail.

Commencing with the blade, inspection will show that its shape has been modified since the first introduction of this

model. As now made, it is of larger section than in earlier types, and the whorl cannot be forced off by a downward blow. The present taper of the blade also allows waste yarn to be easily removed. The structure and method of manufacture of spindle blades has received great attention of late and from the investigations considerable improvement has resulted in concentricity and steadiness.

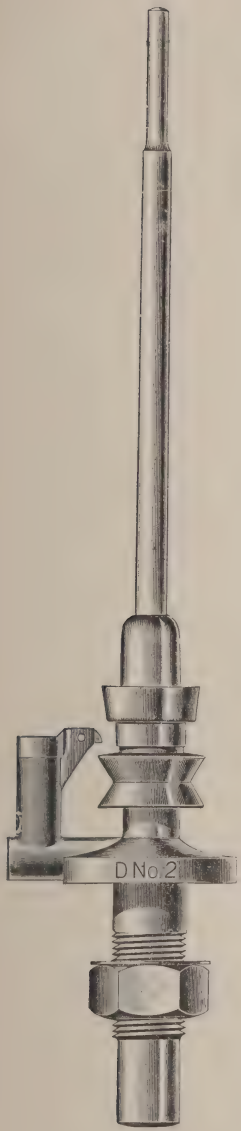
The whorl, which in use is a part of the blade, must be applied so as to be perfectly concentric with it, this necessity involving the use of special tools for fitting and assembling the parts. Sleeve whorls present many difficulties in this direction as the band pull is some distance from the seat of the whorl on the blade.

The base or holder is now universally fitted with the Woodmancy design of oil-tube and doffer-guard, admitted by all to be the neatest and most practical form ever known. Even a simple casting like this has certain troubles of its own. One of the perplexing ones encountered by the trade is the air holes in the metal casting, allowing leakage of oil. We are forced to test our bases under pneumatic pressure to obviate this evil.

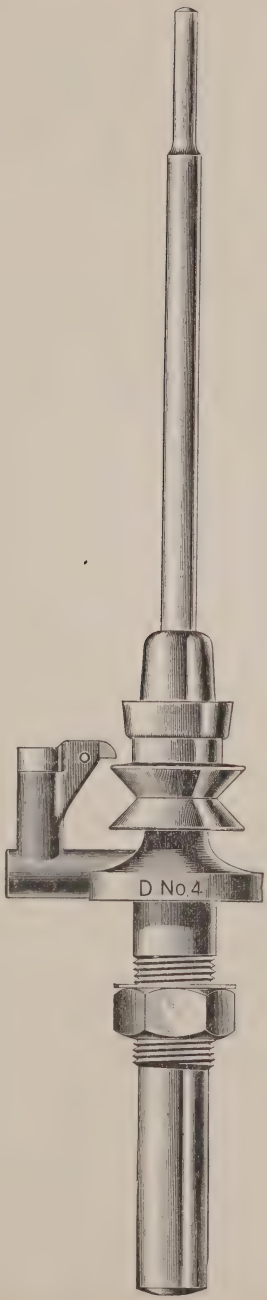
The bolster is another simple piece, but its design and dimensions are vital. The running of the spindle depends largely upon the fit of the bolster in the base and we have brought our gauge limits within 1-1000 of an inch so that each spindle has the same limits of movement so far as mechanical skill can ensure. We still continue to wrap our bolsters with a packing material, as the experience of years has proved that greater steadiness is possible in this way and better wearing results in consequence.

Our steps are still made of hardened steel with flat top, as this combination makes a superior wearing surface. Pointed steps are well enough when the parts are new and well fitted. Wear, however, tends to destroy their proper relation; where, with a flat step, wear at the bottom of the spindle makes no appreciable difference in running. The pointed step is usually used with a soft metal bearing in which it is liable to bore, providing proper lubrication is not present.

The adjustment of the spindle to the bolster involving the spring lock is a characteristic element of this modern spindle. It is possible by good luck to fit a spindle blade to its bolster without the use of an adjusting device; but the fit will not remain the same and in a large number of spindles, uniformity is impossible. With our adjustment the spindle can be more accurately fitted at the start and any future evil may be easily corrected. We have lately improved our spring and the combination is now efficient for all purposes.



DRAPER NO. 2 SPINDLE.



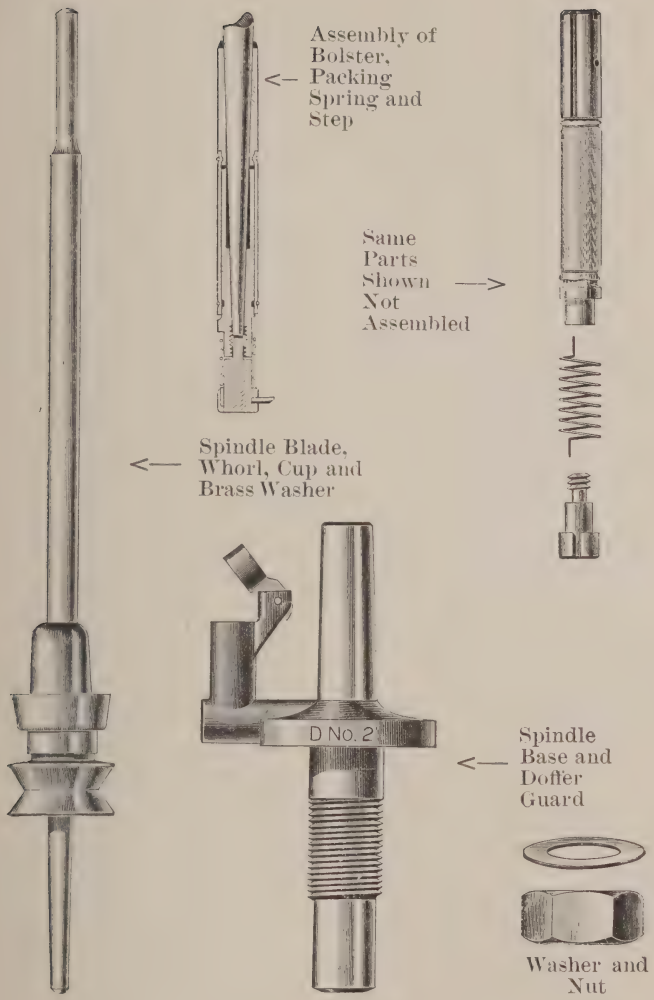
DRAPER NO. 4 SPINDLE.

Referring to the cuts, the different parts can be seen separately. Taking them in absolute detail, they consist, before assembling, of the following pieces:

1. Spindle Blade.
2. Sleeve Whorl.
3. Brass Cup, to aid in positioning Bobbin.
4. Brass Washer, forced on spindle blade under sleeve whorl, to prevent oil from escaping over the top of the base.
5. Bolster.
6. Packing.
7. Strings that secure the packing in position.
8. Spring.
9. Step.
10. Base.
11. Doffer Guard.
12. Pin to prevent step from turning.
13. Nut.
14. Washer.
15. Pin that holds doffer guard.

The Draper No. 4 spindle, or size recommended for heavier work, has the same parts as the Draper No. 2, but in different sizes. Be careful in giving the number of the spindle when ordering.

During the last few years extensive experiments have been carried on in the endeavor to improve the Draper spindle if possible. These tests have involved the continuous running of a test frame and dynamometer for months, and more than thirty distinct mechanical changes have been separately tried. These experiments resulted in certain changes in the blade and spring, but in the main elements and principles no advance has been found possible. Tests of modifications for the purpose of reducing power simply proved that while it was possible to beat the present structure in power consumption, such defeat always involved objectionable conditions or changes whose defects more than counteracted the gain. On the other hand, certain changes in the design of the parts increased the power consumption, showing that the present model is a happy mean between the possible modifications of this type of mechanism. The next improvement in the art will, therefore, have to present a complete change in principle, involving invention of a new order. After having seen the Sawyer type displace the Common and the Rabbeth type displace the Sawyer, we are by no means prepared to deny such a possibility. With both the Common and Sawyer, however, there was a possibility of increased speed which is no longer present. The spindle of today can run much faster than it is possible to spin yarn by reason of limitations in other directions. If an improvement is found it will probably be discovered by those whose education in this line has been most complete.


Assembly of Bolster, Packing Spring and Step
Same Parts Shown Not Assembled
Spindle Blade, Whorl, Cup and Brass Washer
D No. 2
Spindle Base and Doffer Guard
Washer and Nut

SEPARATE PARTS OF DRAPER NO. 2 SPINDLE.

In ordering for repairs it is advisable to let us do the assembling so far as possible. For instance, it would not be advisable for a mill to attempt to put new blades in old whorls. We rarely sell separate parts that are not separately shown on the above page.

THE 49 D SPINDLE.

This type, which we now illustrate mainly for convenience in ordering repairs, once marked a turning point in the spindle industry and its more prominent features are still preserved. It introduced the first taper adjustable bearing, and was the first packed bearing spindle to use the long style of bolster. For saving in power and durability, it was unquestionably superior to any former type.

REPAIR PARTS FOR 49 D SPINDLE.

No. 1—Is the Spindle proper, with Whorl and Cup. We can also supply the new blade shown in the "Draper" Spindle cut with orders for 49 D spindles whether new or on repair lots. It will have to be specified in the order.

No. 2—Is the Brass Collar, which is forced on the Spindle to prevent the oil from rising and flowing out over the outside of the case.

No. 3—Is the Bobbin Positioning Cup.

No. 4—Is the Base; also supplied in Woodmancy pattern.

No. 5—Is the Cap for Oil Reservoir.

No. 6—Is the Retaining Hook.

No. 7—The Bolster.

No. 8—The Packing.

No. 9—The Step.

No. 10—The Pin, of which there are two—one for holding the Step, the other for holding the Bolster in place.

No. 11—Is the Washer.

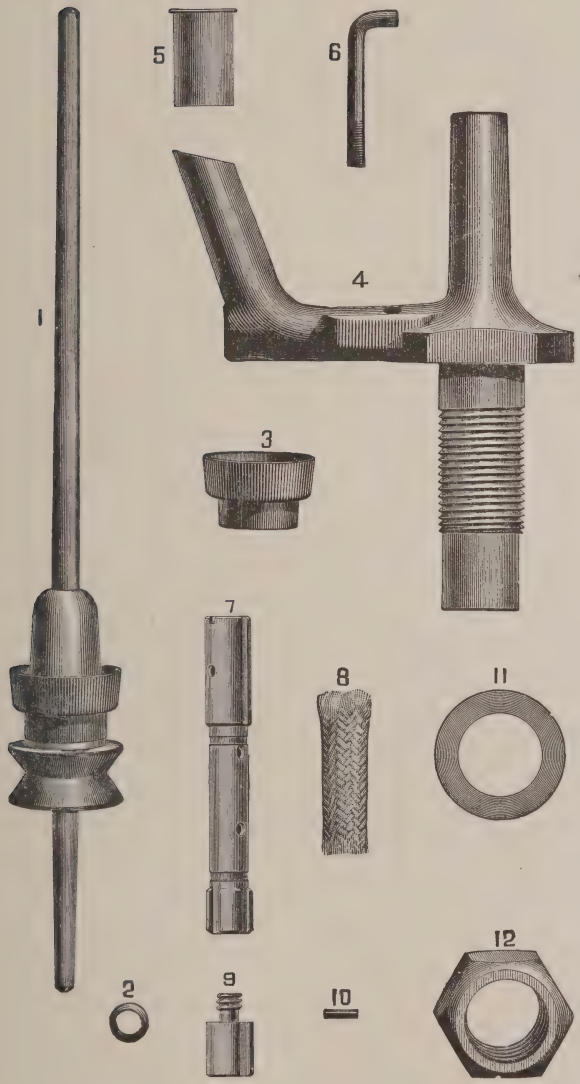
No. 12—The Nut.

Those who order New 49 D spindles at the present day should certainly specify the Woodmancy base and Draper blade. They will then have a spindle like the Draper No. 2 in every feature but the spring lock. This is substantially the combination now used by us on our twister spindles.

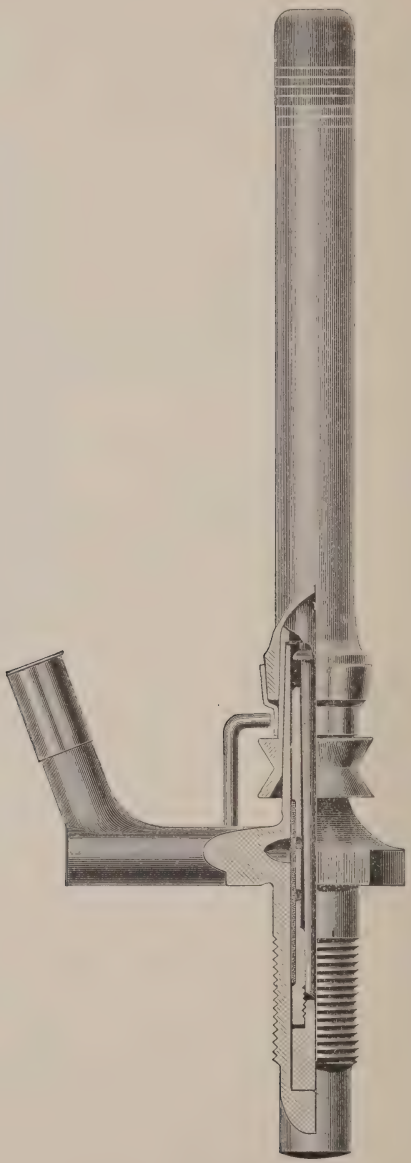
Up to JANUARY 1, 1901, we had sold for the SAWYER SPINDLE COMPANY, either directly or through licensees,

18,443,032 SPINDLES.

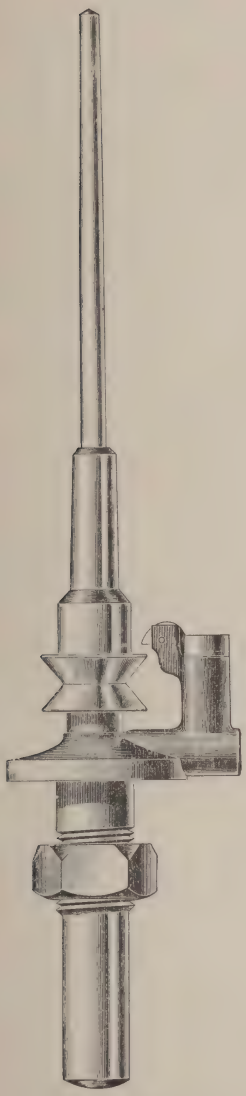
These figures include sales of Sawyer, Rabbeth Sawyer, Rabbeth, Sherman, Whitin, Eureka, McMullan, 49 D, Saco, Pettee, Draper, etc.



PARTS OF 49 D SPINDLE,
Illustrated and named.



49 D Rabbeth Spindle.
Exterior partly exposed.



WHITIN SPINDLE.

As is probably well known, we have complete equipment for manufacture of other spindles controlled by the Sawyer Spindle Company. The Whitin is one of the well known types which is still largely ordered. It has the Woodmancy Dofter Guard and upright oil tube and the general dimensions are similar to those of the Draper. Its main points of difference are in the bobbin seat, which is usually made without the cup, the bearing, which is in one piece and cylindrical in bore, and in the absence of cushion and means for adjustment.

OLD FRAMES.

We have controlled the introduction of high speed spindles in old spinning frames ever since the Sawyer spindle won its earlier victories. We keep a large force of men constantly engaged in revamping old frames and often making them as good as new at small comparative expense. We are always willing to figure on changes, and in view of the surprising results that are often possible it seems strange indeed that any of the earlier types of spindles are still allowed to run. Increase of speed not only increases production, but it may be had without increase of power by the improved models, and labor cost is less per product. We have said so much on this score in the past that it ought not to be necessary to repeat now that ninety-five per cent. of the mills at least, are converted to our doctrine.

After running so long as feasible in the old frames, new spindles which we have supplied can be transferred to new frames, so their purchase for use in old frames involves no chance of loss whatever.

THE MANUFACTURE OF SPINDLES.

There is much in the spindle art that the uninitiated never realize. The workmanship and processes necessary in order to produce millions of structures that will run for years at a speed of thousands of revolutions per minute, is not a matter of ordinary machine practice.

In order to have castings that can be rapidly tooled, a high grade of iron is necessary at the start. The annealing process they are submitted to is different from any other method of its kind, as it was developed in our own works and patented.

The lathes, drills and chucking machines used on this work are of special design, and in many cases involve high inventive skill. They enable cuts to be taken at a rapidity that is surprising, and reduce the labor necessary to the lowest possible point. When the parts are finished they pass to an inspector. Every important cut is gauged and every imperfect piece sent back. On several parts the gauge limit is within one one-thousandth of an inch.

In assembling, the greatest care is used. Special tools are necessary to true the whorl so as to be absolutely concentric. The spindle must be re-straightened after the whorl is on, to cure any chance bend. As parts are all gauged they are interchangeable. Assembling, therefore, only requires skill in adjusting the fit of the spindle in its bearing.

When the spindles are complete they are passed to a further inspector. This man tests each spindle before it is sent out on a specially constructed device that runs each spindle at a speed of 12,000 turns per minute. If there is the slightest vibration or jar the spindle is sent back, and none can be sent out without having been finally pronounced perfect.

The end is not yet. It has been found that in shipping spindles there was liability for damage, owing to severe handling in transit. We have for years used a special form of spindle rack and box that protects the structures so far as human ingenuity can devise.

Were we to make spindles without paying attention to the fine points, and without the critical system of inspection, we could save large sums. Probably a great part of the spindles would run well even then. We have never been content, however, to make an inferior article to save expense, and we do not think that even a severe competition could force us to abandon our present drastic methods. We do not believe that we have controlled the spindle industry entirely by patents. We think careful, consistent improvement in mechanical processes, as demonstrated in the product, has done its share.

SPINNING FRAME SEPARATORS.

We have always made a specialty of the application of separators to old spinning frames, and the sale of separator equipment to manufacturers of new frames. While certain builders have devices of their own, our sales to all parties are considerably larger than the whole total of all other competing attachments. We recommended the Doyle type for years, and still sell moderate quantities. The Rhoades-Chandler construction has practically superseded all the narrow bladed styles, and we have no hesitation in recommending it above every other known type in the market at present.

A spinning frame separator is used to prevent breakage by

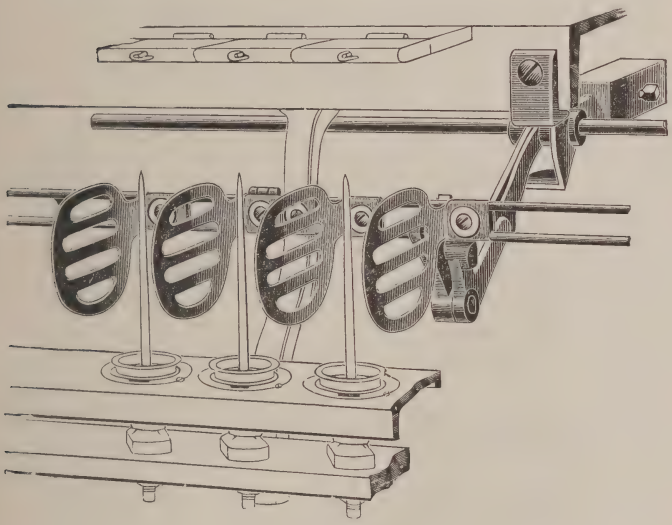


FIGURE I.

the conflict of the yarns on adjacent spindles. They have no other function of importance, being objectionable from every other standpoint. Some inventors have endeavored to lessen their evils, but have usually done so at the expense of efficiency. We ourselves have experimented with dozens of styles that might work well on certain frames, but which were not adapted to varying conditions.

The large ring and longer traverse have made large blades absolutely necessary. It then remained for invention to adopt the use of such blades, allowing them to be retired while doffing is going on, and the Rhoades-Chandler system can most

uniformly meet existing conditions. While the construction allows the blades to be turned up and back for doffing, it also

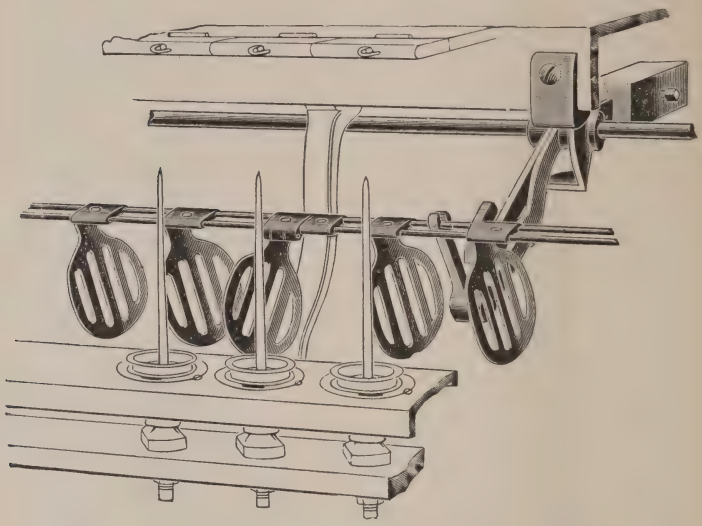


FIGURE II.

allows a down turn as well, which is usually found preferable. Fig. I shows a few blades in the position they occupy when the

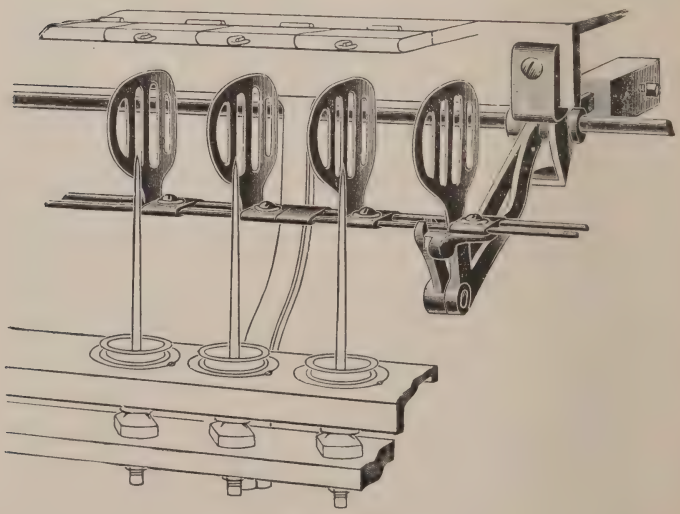
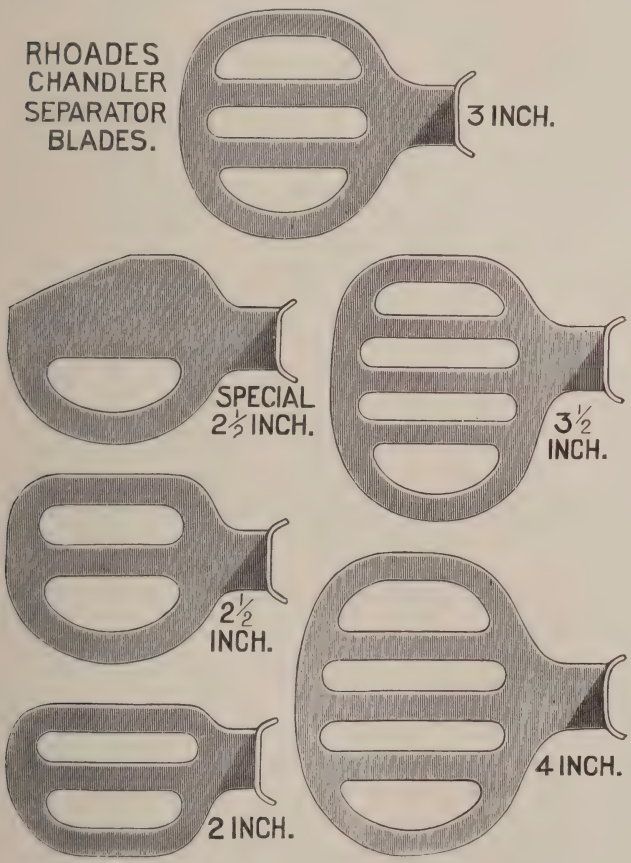


FIGURE III.

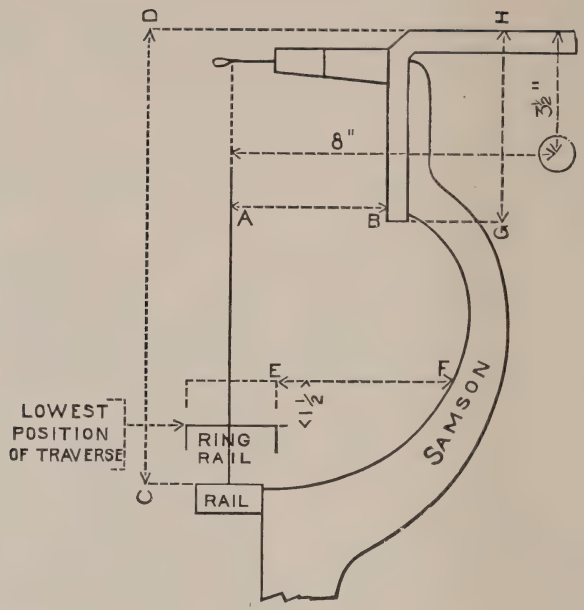
rail is at the lower part of the traverse. The frame of stamped steel blades swings from a pivot in the rear of the roller beam, the long leverage allowing perfect ease of motion. Fig. II. shows the separators turned down for doffing. They need no prop, or other device, to keep them in this position. Fig. III. shows the separators in an up-turned position.

The question of the proper size of blade is of great importance. We can meet any conditions by using different patterns, a few of which are shown.



These blades as shown in the cut are reduced in size.

To JANUARY 1, 1901, we had sold 9,749,032 separators of various types.



SPECIFICATION FOR RHOADES-CHANDLER SEPARATORS.

ORDERED FROM DRAPER COMPANY, HOPEDALE, MASS.

Date, 190

Name of company?

Builder of frames?

Number of frames?

Number of spindles in each frame?

Gauge of frame?

Total length between end spindles?

Length of traverse on bobbin?

Width of ring rail?

Distance top of roller beam to top of bolster rail, C to D?

Distance face of roller beam to center of spindle, A to B?

Distance under side of guide board to bottom of roller beam?

Width of face of roller beam, G to H?

Is there a place to run a rod the length of frame, 8 inches back of spindle and 3½ inches from top of roller beam?

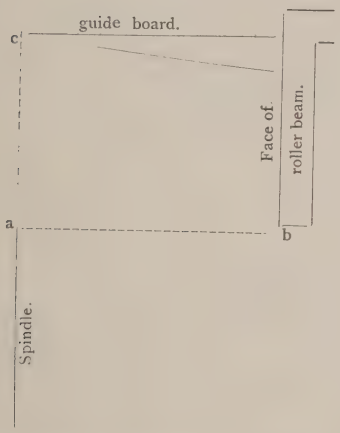
If not, state what is the nearest position such a rod may be placed in? .....

Width of wire board back? .....

Width of wire board drops? .....

Ship via? .....

Blank specification sent on application.....



SPECIFICATIONS FOR DOYLE SEPARATORS.

ORDERED FROM DRAPER CO., HOPEDALE, MASS.

Date, ... 190.....

Name of Company? .....

Number of frames? .....

Number of spindles in each frame? .....

Builder of frame? .....

Gauge of frame? .....

Distance from center of end spindles? .....

Length of traverse on bobbin? .....

Width of ring rail? .....

Distance from face of roller beam to center of spindle? a to b

Distance from top of roller beam to top of bolster rail? .....

Distance from underside of guide board to bottom of roller beam

Width face of roller beam? .....

Width wire board back? .....

Width wire board drops? .....

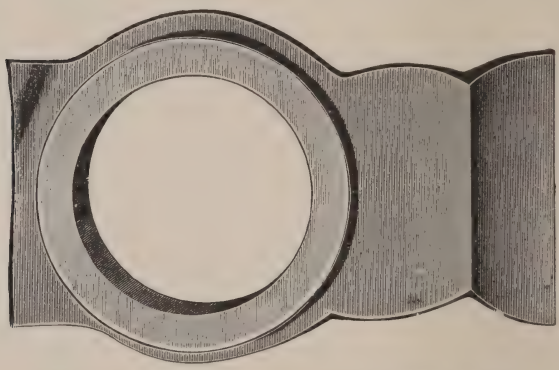
Ship via... .....

Remarks.....

SPINNING RINGS.

The trade form of the ring of to-day is practically identical in shape and appearance, with rings made by us over thirty years ago; and yet the advance in quality and workmanship, by use of improved tools and processes, is of high relative importance. From 1869 to 1886, we were the sole manufacturers of the double flanged ring, our sales for the last ten years of this period averaging over 400,000 rings per year. Even with the immediate competition which then ensued, we sold a higher average of rings than ever, culminating with the record sales of the year 1900, of 1,520,722, making our total sales, to the end of the century, 13,888,736. We have thus still retained leadership in a field where merit alone could win continued favor.

That our rings are the most economical in use is too well



FORGED RING IN BAR WITH CENTRE PUNCHED OUT.

known for argument. We were able to sell them in competition with the single ring back in the years when our prices were double those charged to-day. By figuring the rings sold for replacement, it is proved that they usually ran over twenty years, the life, of course, varying with the speed and size of the traveler. Light travelers wear rings faster than heavy ones; a fact not generally appreciated.

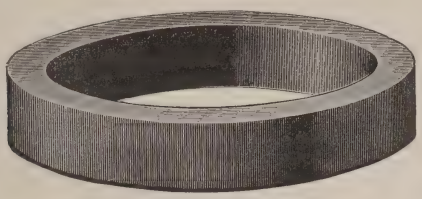
We have formerly called attention to the fact that for several years we have made our rings entirely within our own plant from the rough bar stock, instead of buying forgings outside.

With regard to our process of manufacture, we cannot do

better than to quote from the paper by our Mr. George A. Draper, read at the New England Cotton Manufacturers' meeting held April 28th, 1897.

He stated in part as follows:—

"*The ring of to-day is made from bar steel, drop forged into shape for turning. These forgings, after being properly treated to destroy the*

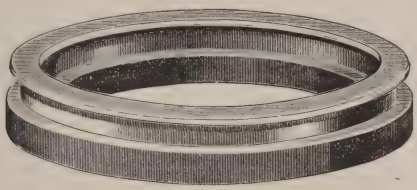


FORGED RING BLANK.

scale, are turned. After being turned, they are inspected, all substantially perfect rings going to the polishers, from them to the hardening furnace, again to the polishers, and finally to the inspectors. Rough turned rings, that is to say, rings with improper surface, but within standard gauges of size, are ground, hardened and polished.

We cut in two each individual bar of stock as it comes to our shops, and have, and often exercise the option of returning this stock to the makers whenever in our judgment it is imperfect.

Great care must be used in forging the blanks from which the rings are turned, to know that the metal is not overheated and yet shall fill the dies. This calls for the exercise of the highest skill. Any large excess of heat, or not heat enough, means a spoiled forging.



RING BLANK AFTER ONE-HALF THE RING IS TURNED.

Our system of ring turning employs two tools working together, one on the inside, the other on the outside of the flange.

The hardening of rings is also of the utmost importance. Rings not hard enough, or unevenly hardened, will wear out rapidly. Rings hardened too much, that is to say, rings hardened at too high a degree of temperature or exposed to heat for too long a time, become changed in

character, the metal becomes granulous and rotten, and the surface becoming glassy.

It is our practice to test several rings from each day's hardening, and if, as we do occasionally, we find that they have been injured, each ring is tested by springing and the injured rings broken in the process are thrown aside.

The finishing of the rings is becoming every day of more and more importance as the art of spinning approaches more nearly perfection. At the present time, rings of a standard of finish of a few years since would not be accepted by any manufacturer. We have within the past year more than doubled our machinery plant for the finishing of rings and at the same time reduced our production one-third to one-half. One man to-day finishes about one-third as many rings as he finished three years ago, and the ring as it comes to him from the hardening furnace is much better than it was then.

The inspection of rings is in itself an art. Our rings are gauged with snap gauges of slight variation, not in excess of two and one-half thousandths of an inch for concentricity of flange; are tested for hardness, for roundness, for smoothness of finish, and for general appearance. Our experience is that from fifty to seventy per cent. of the rings examined by our inspectors are approved. Two-thirds of the rings returned can be made acceptable by better finishing, a proportion of the balance can be made so as to present one perfect flange, and about ten per cent. of the rings sent through to the inspectors are thrown away."

After the great improvement in the finishing of the rings which we have introduced, and which we are glad to say has been universally appreciated by our customers, there seemed to be little left for criticism. One more defect remained, however, which until recently promised to defy betterment.

In order to explain this point fully, we quote from the records of the N. E. Cotton Manufacturers' Association:

Mr. Alfred E. Adams at the '97 spring meeting stated: "*No manufacturer of spinning rings has ever been able to invent a process whereby all the rings will be round when properly tempered.*"

Mr. Edward W. Thomas at the same meeting stated: "*At the time these frames were set up and started we employed an inspector to examine every ring and spindle and follow the setting up gang. He rejected a good many rings. All rings were tested by a gauge and those being out of round were rejected and returned to the makers. So much advantage was found to be gained by this in-*

spection that we made the inspector a permanent fixture, and find it pays. And above all, don't accept from the maker any rings not round. They perhaps may tell you as they do others, that it is impossible to temper a ring and have it keep its proper shape; but don't accept that or the rings either. These rings are better than years ago, we admit, but there is room for improvement yet."

Mr. C. D. Robinson also stated: "*It is a fact that rings or travelers have got to be improved before we can run our spinning any faster. I think the trouble is with the ring more than with the travelers and we have got to improve the ring to have our travelers stay on or not wear out.*"

At the following meeting the same year at Philadelphia, Mr. John W. Pead stated: "*Why accept an imperfect ring? All imperfect ones should be returned.*"

Mr. Ira J. Martin stated: "*All rings should be examined before set, to ascertain whether they are out of round, and if any are found they should be replaced.*"

Mr. John T. Meats stated: "*The production of practically perfect rings is not always obtained. In meeting increased competition and consequently low prices the ring makers do not, or cannot, without loss, produce the very best article possible. It is unfortunate if the makers of rings cannot get enough for their product to warrant the best possible effort, regardless of expense.*"

There was also discussion on this same point at the fall meeting in 1898.

These remarks are referred to simply to show the importance of our latest improvement.

Within the last two years we have been experimenting with a new additional process in the manufacture of rings, by which we are able to produce an absolutely perfect ring.

The idea is so novel, though simple, that the patent office has granted the inventor unusually generous claims. We refer to the patent of Frank M. Marcy, No. 606,675, issued July 5, 1898, and assigned to the Draper Company.

Mr. Marcy stated in the patent: "*In the manufacture of spinning rings it has been found that they are liable to be untrue; that is, they are not of a uniform internal diameter as they are not truly circular. This is due to the unequal structural strains to which the rings are subjected in the process of hardening, as such strains are usually distributed unevenly, and the resulting eccentricity of the ring becomes serious when the ring is in use, as the traveler is obliged to run in an eccentric path, interfering with its regularity of movement and increasing the wear upon it.*

In practicing my invention I take the ring after it has been hardened in any usual manner and re-heat it to a proper tempera-

ture such as will permit subsequent steps without rupture. While the ring is thus heated I force therein an arbor having a tapering end and an adjacent cylindrical portion having preferably a diameter slightly larger than the internal diameter of the heated ring. This effects a gradual and slight stretching of the ring, and while the ring is held upon the arbor it is cooled, preferably by immersion in water or other suitable cooling medium, thus giving the ring a second hardening. The ring while cooling is thus absolutely governed by the arbor or form and the internal strains in the ring are distributed evenly and in such manner that the ring will preserve its shape and true circular curvature after the withdrawal of the form."

The patent claims broadly cover the process of re-heating, expanding, cooling and withdrawal from the arbor, and it is needless to say that we shall defend them to the last limits in the courts. We also control other patented modifications.

Now that we are able to improve our ring we are met with the actual possibility of loss thereby, as it is evident that this extra process involves extra expense. During the last few years we had already greatly increased the cost of manufacture of our rings, especially in giving so much attention to their polishing. It was figured at one time that this department was running at a loss, by reason of lack of orders on which to spread the general expense, although producing at the rate of over four hundred thousand rings per year.

We are unwilling to make poor rings or rings that are comparatively poor. If we believe a process good for the ring, we shall use it. We, therefore, pass all our rings through this re-hardening and truing process. The re-hardening in itself is a great advantage to the metal, as it refines the grain of the steel. Of course, even with the improvement, some of the rings will be better than others, and we have concluded to select the best of our rings to be sold at an additional price of two cents, with an absolute guarantee that they shall be absolutely round within limits of three one-thousandths of an inch. The ring sold at the regular prices will be guaranteed better than our former rings. Inasmuch as customers are used to paying two cents extra for burnishing, they cannot seriously object to paying the cost of a burnished ring for a ring absolutely round, and polished to an extent which will make it superior to any burnished ring ever made.

Manufacturers have told us they would be perfectly willing to pay double the price for rings if we could only give them a better article. We are now prepared to see whether they really mean a small part of it. When we set our guarantee limit at three one-thousandths it simply means that while none

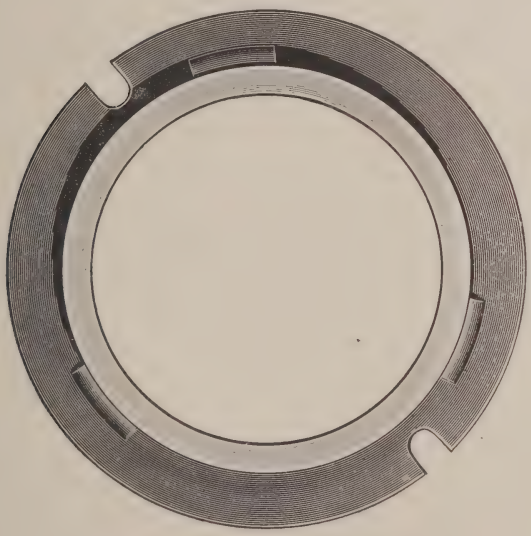
shall be worse than that, the majority will be absolutely perfect or somewhere between perfection and that limit. Even at the outside variation the error is only as 1 to 583 on an inch and three-quarters ring—less in actual extent than the thickness of letter paper.

We could make a large profit out of the ring business were we willing to slur over our inspection, and it is doubtful

SIDE VIEW OF TWO-INCH RING.

whether our customers would soon discover the difference in our standard. Sooner or later, however, the yarn would find it out, and we must always consider its judgment as final.

Rings are even thrown out for defects that have nothing to do whatever with their running or wearing qualities, as our



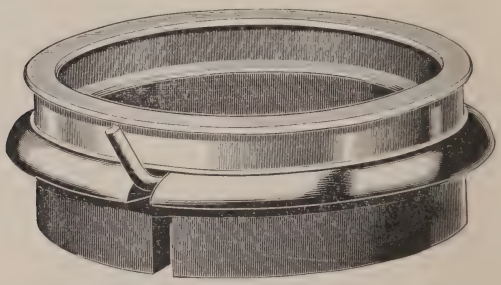
THREE-EARED HOLDER.

standard is so high that they must be perfect in every detail whether important or not. We have also destroyed a large possible profit by the extra cost of polishing, of which the customer gets the entire benefit.

We are glad to say that we no longer hear the old claim that our rings are not so good as those we made in earlier years. This cry arose simultaneously with the use of larger rings and higher speeds, which involved a much harder usage on the same standard product. Our rings now, under the present harsher conditions, are giving better satisfaction than our old rings doing the easier work.

Our new ring involves us in the expense of an entirely new plant for ring holders, as the old two-eared holder would destroy the advantage of the new concentricity. In order to preserve a true circle the new rings must be held by a three-eared holder.

With our former ring the two-eared holder was at times



DOUBLE RING IN CAST IRON HOLDER WITH WIRE TRAVELER CLEARER.

a positive advantage, as it could be used to correct defects by inserting the ring so as to bring the pressure on the largest diameter.

We still furnish the old cast iron holder when desired, though modern mills are almost universally converted to the plate holder principle, especially since we have in late years made them with traveler cleaners.

With our present enlarged plant, we are prepared to furnish anything in the line of rings, including the old single rings, twister rings, etc. We carry a large stock of different sizes and styles of ring and holder and can execute small orders promptly. We make a specialty of ring-screws which are made in our own works. Personal supervision of manufacture protects our customers against the possible chances of inferiority in parts bought from outsiders.

Our regular price list continues in effect as follows, with the exception of the single addition of an extra charge for guaranteed roundness. We have added two new sizes recently —inch, and inch and one-sixteenth ring for very fine spinning.

PRICE OF DOUBLE-ADJUSTABLE RINGS.

With either Cast-Iron or Plate-Holder.

DIAMETER IN INCHES.	PRICE	
	With either Holder.	Without Holder.
1	14 cents.	10 cents.
1 1-16	14 "	10 "
1 1-8	14 "	10 "
1 1-4	14 "	10 "
1 3-8	14 "	10 "
1 1-2	14 "	10 "
1 9-16	14 "	10 "
1 5-8	14 "	10 "
1 11-16	15 "	11 "
1 3-4	16 "	12 "
1 13-16	17 "	13 "
1 7-8	18 "	14 "
1 15-16	19 "	15 "
2	20 "	16 "
2 1-8	22 "	18 "
2 1-4	24 "	20 "

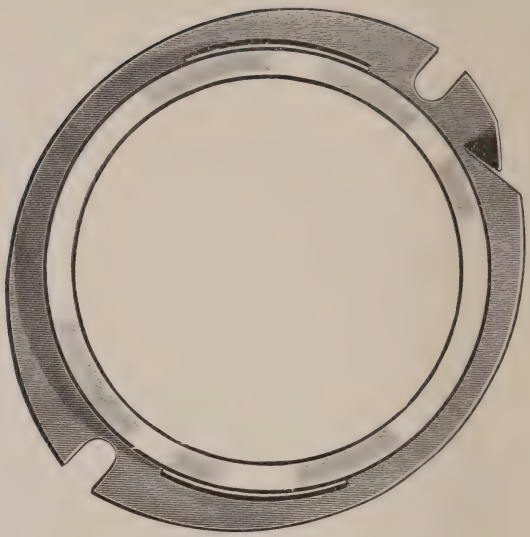
In lots of 5000 or more, a discount of 10 per cent. will be allowed from the above prices.

For guaranteed round, or burnished rings, add two cents per ring to the above prices.

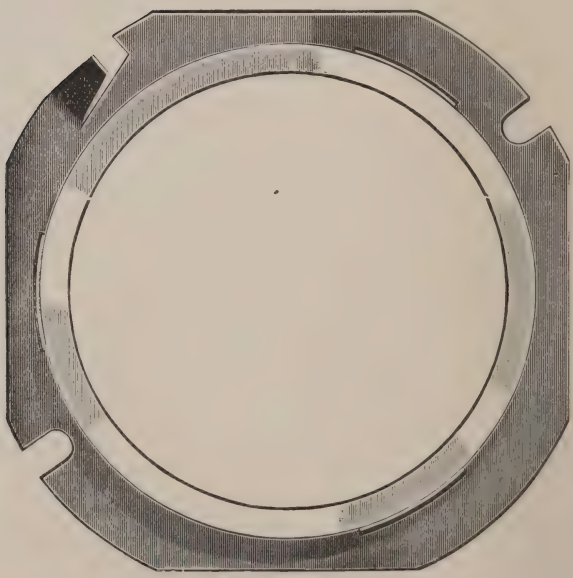
Traveler cleaners free when ordered of the type shown with plate-holders. This is the best one known, presenting no complication of parts, and is always in proper position.

Competent men sent to apply our rings, at cost of time and expenses.

It may not be generally known that we are owners by purchase of the former plant of the Worcester Spinning Ring Company. The stamped metal rings put out before we assumed control have proved absolutely worthless for continued use and we do not recommend their purchase. This little flurry in the trade only added one more chapter to the never endless tale of human experience in which well meant enthusiasm leads good sense astray. Those who start in an industry that is entirely new to them are often deceived by appearances which their experience is not fitted to criticise. They win attention from those who listen to unfounded assertion, and then follows the usual routine of failure, loss, and dissolution.



OVAL HOLDER FOR 2 INCH RING.



SQUARE HOLDER FOR 2 1-4 INCH RING.

SPEAKMAN'S PATENT LEVER SCREW.

Notice the present construction—a Steel Screw and a Steel Wire—unbreakable and indestructible.

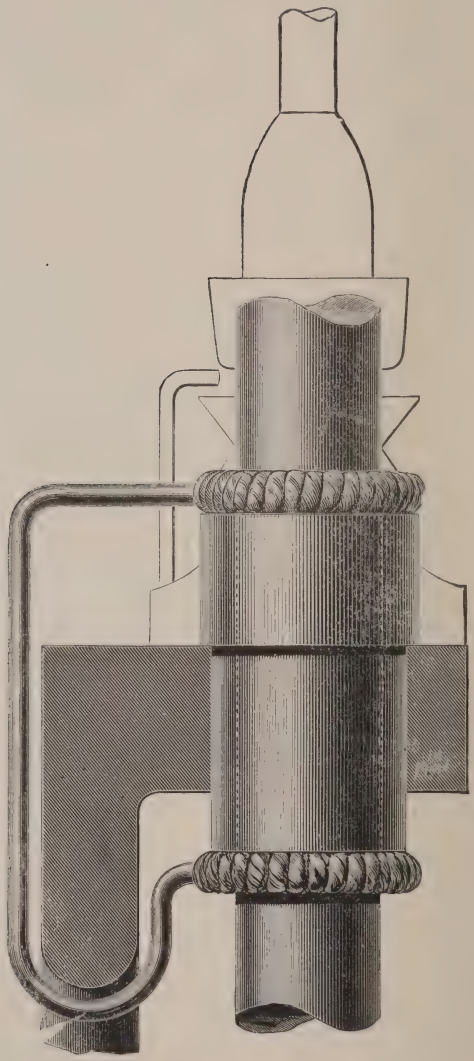
The Speakman Lever Screw is constructed of two parts, a wire hook and a screw which rotates around the hook. The wire is headed so that the upward or downward movement of the screw carries the hook up or down the same vertical distance, without, however causing it to rotate.

On ordinary spinning and roving frames the back weight levers get out of position constantly, causing an endless source of annoyance. The only way to adjust with the ordinary lever screw, is to stop two to four ends, take off the back weight, remove the lever from the stirrup and screw and use it as a lever to turn the screw up or down until it is properly adjusted. The disadvantages of this proceeding are known to every second hand. In the first place, the ends have to be pieced again, and production is stopped from those rolls during the operation. The back weights are liable to be dropped on to the cylinder or bands incurring a waste of time and perhaps damage. The lever will probably become bent as it was never designed as a screw driver, and the stirrup often falls between the steel rolls, making serious repairs necessary.

Compare the above operation with that in use on the Speakman screw. All that is needed is to turn the screw slightly by means of a wrench, without stopping an end or moving a piece. With the old screw, half a turn is the least you can get, while with the Speakman as much or as little rotation as is necessary may be obtained.

In ordering new frames it is inexcusable to accept the old style. It will pay well to change over old frames. Send us a quantity order with a sample of the screw you are using, and we will cut a similar thread without extra charge.

The careful spinner is ever on the watch for real improvements. It is mainly by the combination of small improvements that success is maintained.



SHAW & FLINN'S PATENT LIFTING ROD CLEANER.

May now be purchased at one-half former price.

SHAW & FLINN'S PATENT LIFTING ROD CLEANER.

This simple and practical invention, which is shown in cut on opposite side, full size for three-quarter inch lifting rod, is the result of a necessity for something that will prevent the frequent stopping of lifting rods and the ring rails they carry.

Everyone familiar with the details of spinning cotton yarn knows that dirt and lint will adhere to the lifting rods and be carried into the bushings or guides set in the frames for the rods to work in; this accumulation of dirt will wear the rods, and sooner or later is liable to stop one or more on a frame.

This attachment is made of wire, covered where it passes round the lifting rod with a twisted and braided cord which fits the rod closely, but not tight enough to cause undue friction; the elasticity of the wire and its covering prevents any liability of the rod sticking on account of collection of dirt. The two parts or covered rings are formed at the ends of one piece of wire, which is bent to pass over the back side of the rail holding the bushing through which the rods run. In forming the cleaner, sufficient spring is given to the wire to cause the rings to fit closely to the top and bottom of the bushing.

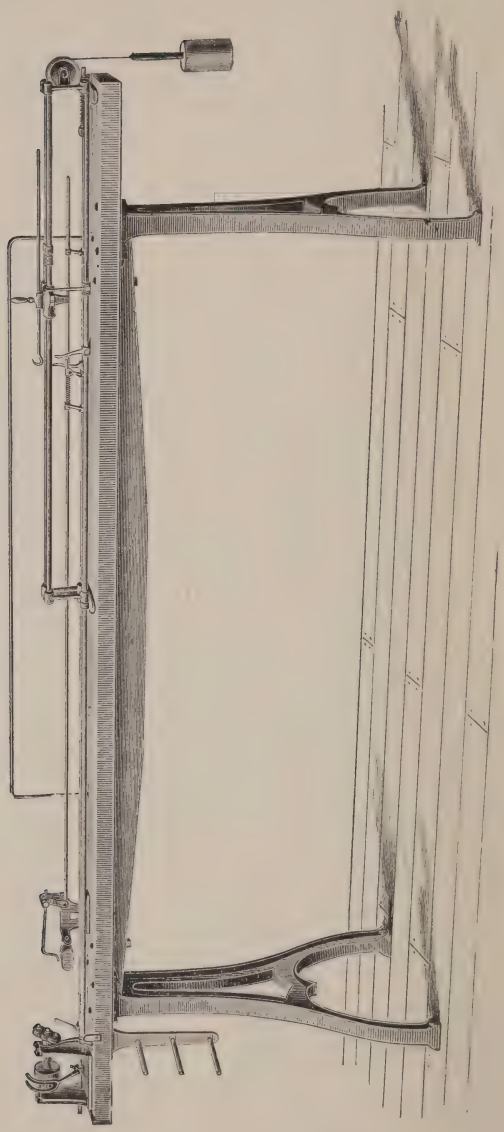
The lifting rod cleaner has been in use for years, giving satisfaction, and those who use it extensively consider it a desirable improvement. We recommend it as a cheap and convenient attachment, requiring but a moment to put on, effectually preventing wear and sticking of lifting rods, adding to the neatness of frames, and reducing the amount of oil required for lubricating the rods to the least possible quantity. They will not require oiling more than once in two or three weeks.

We have recently cut the price in two giving strong reason for universal adoption.

SPECIFICATIONS FOR ORDERING SHAW & FLINN'S PATENT LIFTING ROD CLEANER.

Number and diameter of Lifting Rods .....
Width of upper and lower rails .....
Thickness of each front and back .....
Length, small diameter, and height above rails of bushings .....
Distance from back of rail to centre of rod .....
If a guide for lifting rod is used below lower rail, give length where rod passes through .....
The thickness of front and back of rails is wanted in case a box or flanged rail is used .....

Blank specification, with diagrams for convenience in taking necessary measurements, will be sent on application.



WEEKS BANDING MACHINE

With Watter's Marker.

THE WEEKS BANDING MACHINE.

This is a standard trade machine for making bands for spinning and twisting frames. It is automatic in action, changing from twisting to doubling, and stopping itself when the band is done. It can be set so as to get any desired amount of twist, making either a hard or soft band. The twist will always be uniform. Its simplicity will recommend it to all. There are machines in the market which perform more operations, dispensing with a slight amount of hand labor, but the additional complication, and demand for mechanical skill in adjustment and labor, make them hardly adapted for the usual spinning room requirements. Our machine is usually run by a boy, and its capacity is only limited by the individual skill and quickness of the operative. 1500 bands a day is by no means a maximum. The machine is usually run at a speed of about 2000 revolutions. A few years ago we completely re-designed the entire construction, making the whole much stronger and more durable.

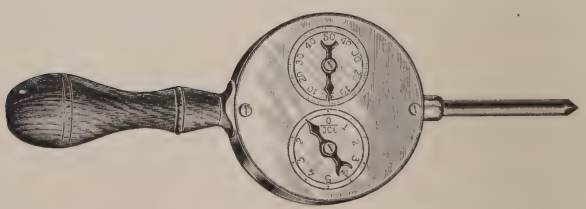
The subject of spindle banding has always had a peculiar interest for the practical manufacturer, as it not only represents a continual annoyance, but hides a very important factor in misuse of power. Bands continually break, and their tension goes through surprising changes. A new band, if put on at high tension, proceeds to slacken materially, and then by absorption of moisture or oil, usually tightens and grows hard and wiry. If the frames are not kept well cleaned, the bands will also load up with fluff, thus increasing their diameter and tension. In certain experiments with spindles that did not require oiling, it was found that bands wore out very rapidly, proving that the absorption of the oil spray, which is always present near a spinning frame, is of considerable benefit. Those who have started new frames have also noticed, repeatedly, that bands wore out much quicker when running bare spindles than when the spindles are spinning. This must be accounted for by the extra amount of flapping, caused by not having work enough to do.

Bands have been made of various materials and composition, but cotton roving and cotton thread seem to have outlived all others. While it will not do to have slack yarn, the method of prevention by tying very tight bands is decidedly objectionable, as the power taken increases enormously, and the spindles are rapidly worn out. In order to prevent a high tension, some mills use small bands, which cannot be tied very tightly without breaking. One prominent spinner uses bands as light as 230 to the pound, put on at a tension of 2½ pounds,

and claims their average life to be 10 months, running spindles at 9400 revolutions on 29s warp yarn, 6″ traverse, and 1¾ rings. The same party advised brushing the cylinder at least every 10 days, to keep bands free from oil and lint, with inspection at the same time to detect slack bands, which should be cut off. These bands were made from 8 hank roving, using 8 strands with a core of 8 threads of No. 30 yarn. The band was not hard twisted, about 3 turns per inch. They were tied with a loop knot, and were marked bands.

This brings us to a consideration of the WATTERS IMPROVEMENT for the WEEKS BANDING MACHINE, which is arranged to automatically make a mark on the band at a definite length, for the purpose of showing the band boy where the knot should be tied. By this means, an *even tension* can be had on all spindles, within very fine limits. The attachment is very *simple and automatic*, and furnishes a cheap method of accomplishing a long desired end. Hundreds of mills use the idea, and we sell them on nearly every machine that we send out. A universal and intelligent use of this system would save more horse power than is now generated for use at Niagara Falls. (Refer back to the data on Band Tension, included in the former remarks on Power Tests.)

Several mills have made interesting experiments with mercerized cotton yarn for bands, on the theory that the stretch was already taken out. It certainly is advisable to remove the possibilities for stretch as much as possible, before putting them on. Certain experiments are also in progress concerning the treatment of bands with different compounds, to make them more durable. We simply mention these ideas to start possible experiments by those in position to profit by improvement.



We supply speed counters like the above, when ordered. They are of great assistance in taking spindle speed, by connection with a piece of rubber tubing.

BAND TENSION SCALE.

This device is to the spinning room, what an indicator is to the engine room. It multiplies the efficiency of the overseer, or second hand, although the results are shown at the coal pile, rather than in their immediate department. It is however, important to the spinning-room itself, to have its bands well adjusted to a uniform scale of tension, so that they will wear longer, and protect the weave room against slack yarn. The band scale absolutely determines the exact tension of any band, or number of bands. We have recently improved the construction, so that one scale will do for different whorls, doing away with the necessity of a complete scale for each style of spindle in the room.

To use the scale, the frame must be stopped, and if the spindle is of the old type with a hook, the hook must be turned. The whorl of the scale is then applied by its slot, under the whorl of the spindle, which will thereby be raised, and the band is slipped off the spindle whorl onto the band scale whorl. By drawing the lower whorl even with the spindle whorl, the tension is shown on the scales. New bands should pull from three to four pounds. It is a great mistake to put them on at any higher tension. A spindle should run with a pull of one pound and if they do not turn freely with this tension, they either need oiling or are too tight in their bearings.

We charge $10 each for these scales, and as the demand is not sufficient to warrant tools for making them in large quantities, there is no profit at this figure. They can be made to earn their cost many times over in a very short time, by intelligent use. Send sample spindle with order or specify spindles accurately.

SPINNING FILLING ON RING FRAMES.

The greatly increased use of frame filling in the past decade, undoubtedly received its first impulse from the introduction of the evener by the late George Draper. While many frames are now built for filling without the evener attachment, it is doubtful if manufacturers would ever have appreciated the gain in spinning filling on ring frames if it had not been for the persistent efforts made during the introduction of the evener. We have faith in this device, and recommend it wherever our recommendation is appreciated. Comparative tests have proved that yarn could be spun with less twist and less breakages, when this invention is used. Manufacturers have, however, found that filling can be spun on frames without the evener, and many do not care to pay the additional cost. In one way, this makes no difference to us, as we have never taken royalty for the evener, and have no chance for profit in its introduction, except as it may cause more filling spindles to be used. We do not mean to say that filling was never spun on ring frames before the introduction of the evener. Certain hard-twisted coarse filling had been successfully made, but no one attempted to spin slack-twisted filling of the finer numbers. We think that experience has now proved that filling as fine as 80s, and all numbers up to 80s, can be spun on frames to better advantage than on mules, all things considered. With the evener, filling yarn can be spun as slack as it need be for any purpose; it can also be wound harder on the bobbin, as a heavier traveler can be used with the evener than without it. The advantages of bobbin filling are less waste in weaving, less breakage of the filling in weaving out of the shuttle, less cost per pound for labor, less floor space necessary for machinery. There is also one less department in the mill, one less overseer, and a class of help is dispensed with that mill management has always found troublesome.

That the mule is going out of fashion, can be easily proved by noting the equipment of modern new mills. No doubt the improvements in spindles, rings and separators have aided this result.

A new advantage of frame filling is introduced with the use of the Northrop loom; while cops can be used with this loom, their use involves the operation of skewering the cops before placing in the loom hoppers. While this is not a serious disadvantage, it does take extra time and adds an additional expense for skewers.

THE

PEARSON CONDITIONING MACHINE.

Filling yarn to weave to the best advantage should be conditioned before going into the looms.

We have secured rights controlling the introduction of the Pearson method of conditioning yarn in this country, and we take pleasure in calling the attention of American manufacturers to a system that has already won recognition in England and on the Continent.

No textile manufacturer needs to read about the advantages of properly conditioned yarn. It weaves with less breakage, needs less shuttle tension, weaves without kinks, makes less cop waste and less fluff and gives a better and brighter surface or cover to the cloth. Having granted that these points are desirable, the manufacturer has been perplexed to find a proper method by which to obtain them. Former devices have involved the use of the water can, the steam jet and the damp cellar. Certain machines have also been constructed involving the use of humidifying apparatus. The results have not been uniform in character, and have involved a considerable length of time.

The Pearson machine solves the problem by practical manipulation, being cheap, quick and positive. The machine, as shown by the cut, resembles an elongated bedstead, with a sheet of still greater length, having its surplus wound on a roll. This sheet passes from the roll into a trough of water, and then through rubber compression rolls, which squeeze out any surplus moisture. The bobbins or cops are deposited on the sheet to the depth of a few inches, a surplus layer of the damp cloth is then folded over them and the process repeated by further layers, the sides of the machine being built up by removable boards until the full capacity is attained. By this process, the yarn is subject to actual contact with a positive moistener and the capillary attraction of the fibre insures a uniform distribution within a proper length of time.

There is no need for theorizing or explanation, as the results desired are satisfactorily obtained in practice, there being thousands of these machines already in use. Where filling is wound on bobbins and then subject to steaming or spraying, the wood is bound to swell and warp more or less, so that the bobbin will not fit the spindle properly. This involves repeated reaming and great loss. With the Pearson system it is found that the bobbins are not affected to the same extent. No

THE PEARSON CONDITIONING MACHINE.
Shown with boards on one side removed.

power other than hand power is required for the operation, and any cheap extra space, can be utilized.

The system is quite as important for worsted as for cotton yarns. Twelve to twenty-four hours in the conditioning machine will insure at least four per cent. of additional moisture, and this four per cent. will be uniformly distributed. Mills accustomed to age their filling for two weeks or more, should be able to appreciate these figures. Cotton fibre naturally holds a certain amount of moisture, and will retain a certain per cent. of weight under normal conditions. In passing through the mill machinery it loses this moisture and the conditioning process simply returns the loss. In England, where yarn is made in one mill and sold to another, it is invariably conditioned, the purchaser being satisfied to pay for the moisture by the reason of the better condition of the yarn for its intended purposes. An advantage which is recognized as raising the value of water to an equivalent basis with spun yarn, is certainly worthy a proper investigation and trial.

The capacity of the machine is from 1000 to 1400 pounds per day. There can be no stain or mildew from the process. The actual gain in the breaking strength of the yarn can be easily determined by the ordinary testing apparatus, and it uniformly shows in favor of the conditioning process. Dimensions of machine over all, 19x4½ feet.

Americans must admit that our foreign competitors have made yarn for many years beyond our time, and we should stand ever ready to profit from the results of their experience. We have adopted their carding system, are learning the value of their weave sheds, and must recognize that they are past masters in the conditioning of yarn. Why not accept their most approved process rather than pass through each stage of the same slow and expensive evolution?

INSTRUCTIONS FOR WORKING PATENT YARN CONDITIONING MACHINE.

Before beginning to charge the machine with yarn, place the sideboards in the slots of the uprights, all the way round, and then proceed to fill in the yarn in layers as required, until it rises level with top of the sides, when another lot of sideboards must be put on.

Insert the web of cloth between the squeezing rollers, then pull it the whole length of the machine and lay it flat on the table and place in position the hollow brass tube, through which the wrought iron-rod with handle has been previously inserted. Cover the cloth with yarn completely, then insert

the hollow brass roller, with polished brass stud on knobs at each end, between the uprights, and attach the loops to the studs on each end of the brass roller.

Turn the handle. The cords will then raise the brass roller, and the cloth will be carried the full length of the machine, and deposited upon the layers of yarn previously laid, without rubbing or disturbing them.

Continue this process until the machine is charged full. The cops, spools or hanks may be put on the machine, in one, two or more layers, i. e. two or three deep, between each layer or sheets.

The amount of moisture in the cloth can be regulated by weights on the lever.

At the commencement, the weights should be placed at the extreme end of the lever and gradually moved inward as the desired amount of moisture, (say 6 per cent.) contained by the cloth is ascertained.

To ascertain the exact amount of moisture absorbed by the yarn, it will of course be necessary to weigh it, before and after it is conditioned, after the first two or three tests only.

Fill the trough with fresh clean water.

When the machine has been charged with yarn, empty the water trough, so that the sheet will not pass through water when being rewound on the roller, when the machine is being emptied.

On no account must the cloth be wound back on to the roller before the trough is emptied.

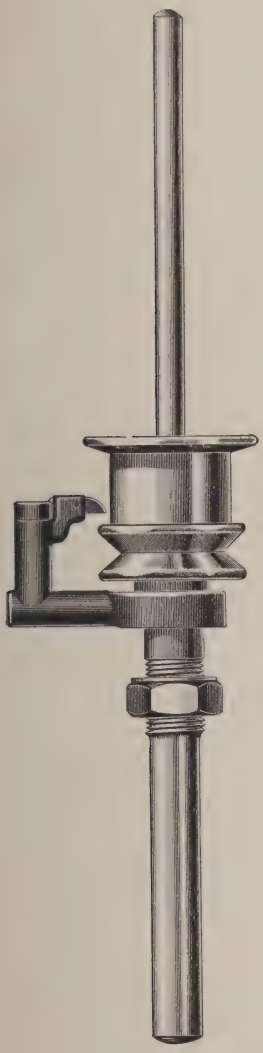
Although it is not at all necessary for ordinary yarn, sheets of unglazed paper may be used with advantage, on high class yarns, or, if through any reason, or by accident, the web or sheet of cloth becomes soiled or dirty.

The paper will last several months, three lengths should cover the machine, and they should be 4 inches wider than the cloth, so as to project 2″ on each side.

These sheets of paper are to be placed onto the wet cloth when it has been drawn across, before putting the yarn on, and after the layer of yarn is placed, another lot of paper sheets should be put on the top, before drawing the wet cloth across again, so that nothing but pure damp goes through the yarn as the sheet or web of cloth does not actually touch the yarn.

Care must be taken to place the paper between the rod or brass tube, which holds the cloth at the working or trough end of the machine, and the yarn, in order to prevent any water, which may run off of the cloth from getting on to the yarn and over conditioning it.

THE HOPEDALE SPOOLER.

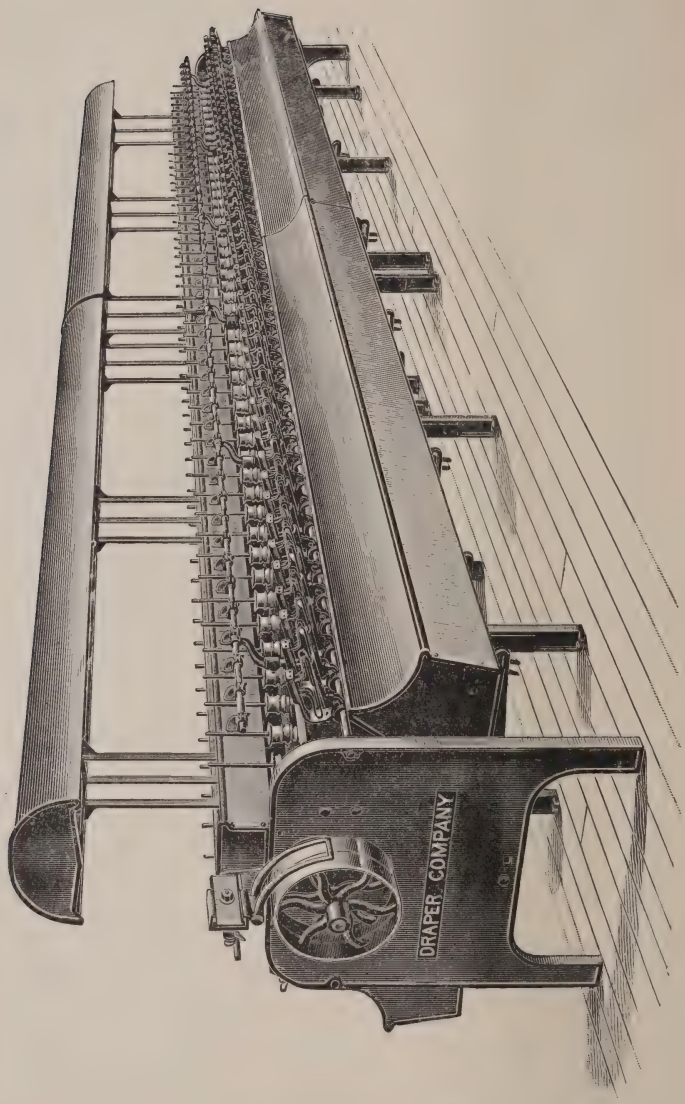


The spooling of yarn is a process involving a high percentage of labor cost, and while the labor is paid at a certain rate per product, it is still of great importance to lessen the element of attendance as much as possible. We claim that all the important improvements in spooler construction have originated with us, as we introduced the Wade Bobbin Holder, the first Iron Frame Construction, all the more popular types of Spooler Guide and the present Steel Boxes and Creels. We continually present new improvements that prevent equal competition by others on any basis but price. The careful purchasers will recognize the element of value received, and to such we present the following reasons for first consideration:

SPINDLES.

We use the Single Rail type universally now, and provide it with the Woodmancy Retaining Lock and Oil Cover. In our single rail spooler, we are enabled to adopt a form of construction which is very rigid and strong by use of sheet metal plates, which extend the full length of the spooler below the rail.

No one questions our ability to make satisfactory spindles of any type.



THE HOPEDALE SPOOLER.

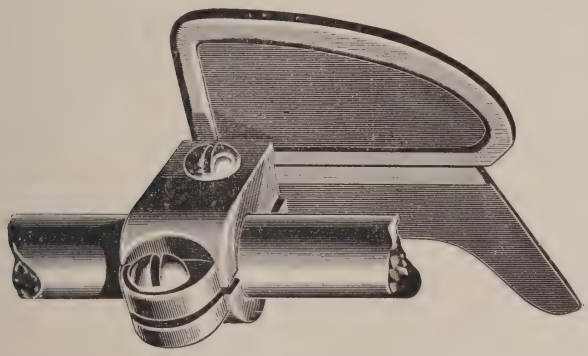
Cut does not show adjustable legs, as on latest construction.

CONSTRUCTION.

This is an age of metal, and our spooler is typical in being constructed without one particle of wood. We are the only builders using steel creels and boxes, thereby doing away with slivers in the yarn, and reducing the repair account very materially. Another important feature of our construction is the use of adjustable legs in the frame, so that the height of the machine may be suited to the operative. Small help is used in some mills, and full grown help in others. The motions required in spooling are very fatiguing, if the spindles are not at a proper height for easy manipulation, and this height necessarily varies with the height of the attendant. We have been careful in our late designs, to have plain, simple surfaces, not liable to catch dirt or lint.

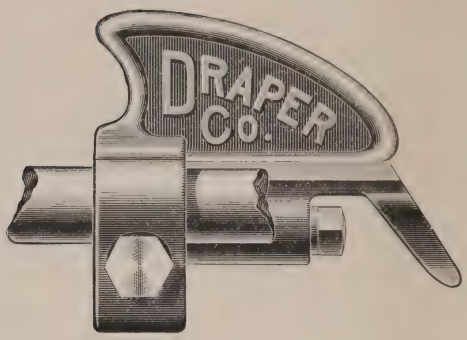
GUIDES.

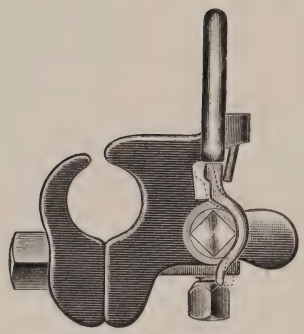
We make Spooler Guides in several patterns, to meet the demands of customers, and explain their peculiarities without prejudice, leaving the customer to determine the selection.



NORTHROP GUIDE.

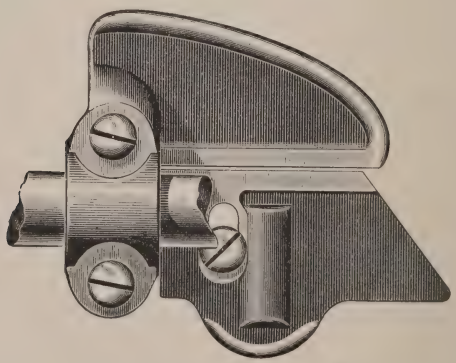
The Northrop Guide is now made in the style shown, which is slightly different from the original form, but more serviceable in its present shape. While very simple in construction, it is admittedly difficult to clean, and the method of fastening and adjustment has been thought to be open to improvement.

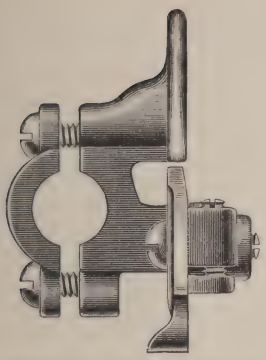




IMPROVED NORTHROP GUIDE.

The Improved Northrop Guide has its lower jaw held on an eccentric bolt, enabling a positive and accurate adjustment without disturbing the fastening device. If the slot becomes clogged, the lower jaw may be tipped slightly to the front, exposing the edge so that the operative may remove any lint with ease. The slot remains the same width, in spite of its freedom to turn, thereby preventing the operative from enlarging it by any designed manipulation. With this guide, the rod on which the yarn rests may be turned to present a new wearing surface, without changing the adjustment of the guide-slots. The guide-slot will always be uniform in width.





THE LAWRENCE GUIDE.

(Note cut at bottom of page 184 for front view.)

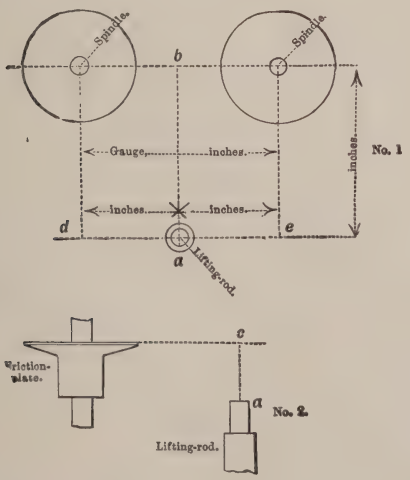
This construction has met with great favor, being similar to the Improved Northrop in results, though even easier to clean. In the Lawrence construction, the lower blade is controlled by a hidden spring, which may be compressed so as to open the slot temporarily, for removal of bunches. A separate screw adjustment enables change in width of slot without affecting the fastening device.

SPECIFICATIONS OF SPOOLER GUIDES ON SPOOLERS MADE BY OTHER BUILDERS,

ORDERED FROM THE DRAPER COMPANY, HOPEDALE, MASS.

For ....

Date 190



Answer the following questions:

Which Guide will you have, Northrop, Improved Northrop or Lawrence? ....

Give number of Spoolers? ....

Number of Spindles in each? ....

Builder of Spooler? ....

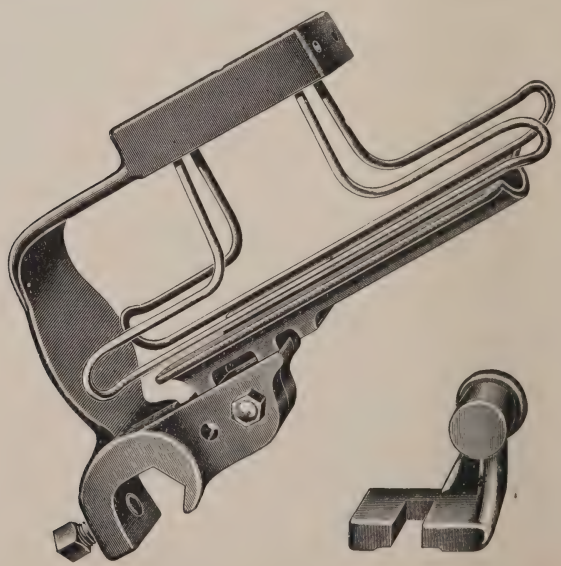
Are Lifting Rods in the Spindle Rail? .....
Are Lifting Rods in front of the Spindle Rail? .....
Are Lifting Rods behind the Spindle Rail? .....
Give total length between end Spindles? ....ft... .... in.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60

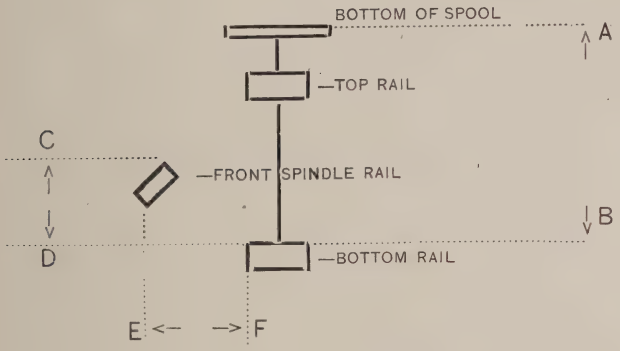
Mark X between Spindles where Lifting Rods come. If they come opposite Spindles put X on the Spindle line.

Distance between centres of adjacent Spindles, that is the gauge? .....
Distance A to B (Diagram No. 1)? .....
Distance A to C (Diagram No. 2. When lifting rod is at the lowest point of traverse)? .....
Distance D to A on Diagram No. 1? .....
Distance A to E on Diagram No. 1? .....
Distance from top of lifting rod at lowest point of traverse to top of upper bearing which rod runs through? .....
Distance from bottom of lifting rod at highest point of traverse to bottom of lower bearing which rods run through? .....
Size and shape of top three inches of lifting rod (See Diagram No. 2)? .....
Remarks .....



BOBBIN HOLDERS.

Our latest construction is of an adjustable pattern, which may be used for different sizes of bobbins and yarn diameters, thereby saving expense when changes are made. The wires must of necessity be adapted to the yarn spooled, but the other parts simply need proper setting for the requirements. When a round rod is not found on old styles of spoolers, we use the small foot piece found at the right of cut. We can of course, send side spindles, instead of bobbin holders, when demanded.



SPECIFICATION FOR LAWRENCE BOBBIN HOLDER.

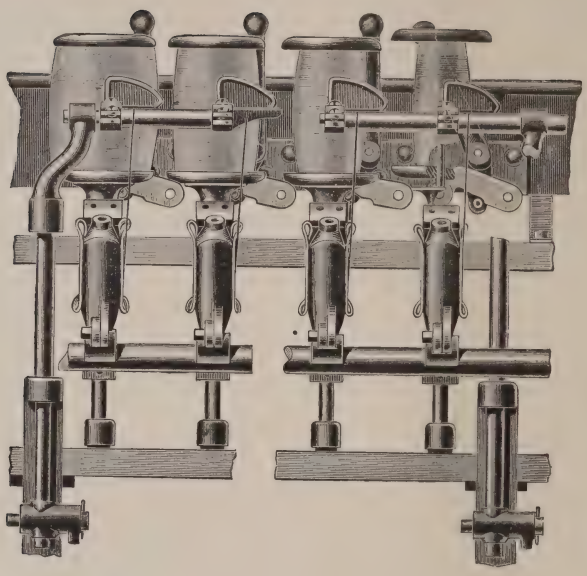
ORDERED FROM DRAPER COMPANY, HOPEDALE, MASS.

QUESTIONS TO BE ANSWERED.

How many Spoolers? .....
No. of Spindles each? .....
Traverse of Bobbin? .....
No. of Yarn? .....
Size Ring? .....
To attach to Round Rod or Flat Rail.....

Additional information wanted if Round Rods and Stands are to be applied.

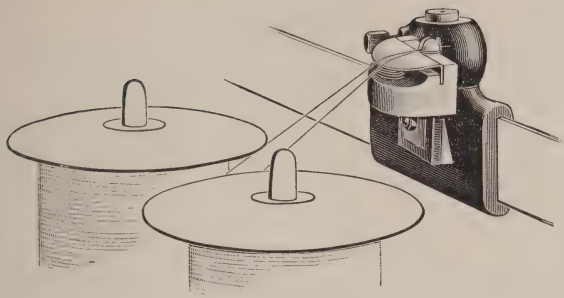
What make Spooler? .....
Gauge? .....
Distance between end Spindles? .....
Distance from Bottom of Spool to top of Bottom Rail (A to B in diagram) .....
Distance from top of Front Spindle Rail to top of Bottom Rail (C to D) .....
Distance from lower corner of Front Spindle Rail to outer face of Rail (E to F).....



SPOOL RAISING DEVICE.

This attachment allows the operative to stop the spool by a simple lever movement, in order to aid while tying knots. It has been found of considerable assistance when weaver's knots are required. Its additional parts involve an extra charge of 25 cents per spindle.

The question of knots at the spooler has deservedly assumed considerable prominence in recent years, as it is easily proved that three-quarters of the warp breakage at the loom is due to large knots, or knots with long ends. We have attempted to introduce various knot tying devices, which have been found more or less efficient. The majority of them have been designed for the purpose of cutting the ends off of the usual spooler knot, or tying the spooler knot with short ends. This does not however, entirely solve the problem. Actual measurement will show that a spooler's knot is considerably larger than a weaver's knot, and much more liable to cause breakage. There seems to be no reason why weaver's knots, cannot be enforced: in fact many American mills, and a large majority of foreign mills, use no other style. As this recommendation on our part prevents profit from certain of our knot tying devices, it can certainly be read without criticism of our motive.



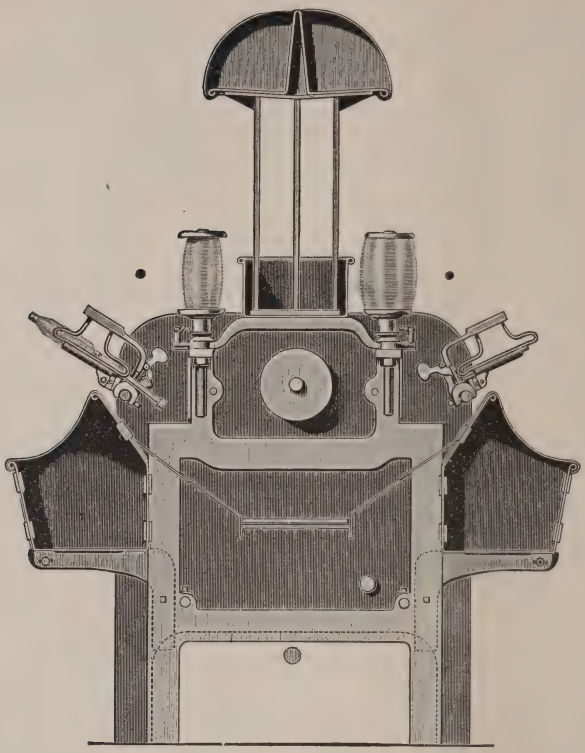
KNOT-TYERS.

While we have advertised and introduced various forms of Knot-Tyers in the past, the survival of the fittest seems at present to bring the McVeigh Knot-Tyer into the first rank. This simple mechanism allows the tying of a spooler knot by automatic methods, with short ends. We attach a rod to the lower creel box, so arranged that one or two knot-tyers may slide on it and be used by a spooler tender for a large range in number of spindles. We are thus enabled to put a high grade of tool work into the mechanism without adding largely to the expense per spooler.

Other improvements in detail of spooler construction, relate to compound rocker arms to prevent damage in case a falling spool gets under the descending guide rod. We build various constructions for varied purposes, to meet the demands of customers.

We realize perfectly that it is impossible for us to control the spooler trade on the basis of merit alone, as many orders are given in conjunction with orders for spinning machinery, it being quite natural for a purchaser to get his spoolers from the same parties who make his frames.

We know of no possible present conditions under which another make of spooler could give a proper basis of argument against our type, for no other spooler has so many improvements, and no other even attempts to substitute devices to accomplish all of our important results. Much machinery of every sort, is bought by those more or less new to the business, and such are apt to be influenced, more or less, by the persuasions of personal appeal. We rely on no general terms of comparison, but are willing to explain in absolute detail, the precise reasons why we should be favored with orders, and simply ask for intelligent and careful consideration of the evidence presented.



TRAVELLING BELT SPOOLER.

We now illustrate our latest novelty in Spoolers, namely: our new Travelling Belt Spooler, with sheet metal chutes, adjustable belt tightener, and Clark Bobbin Holder. While we have built travelling belt spoolers of an older design for many customers in the past, it is only quite recently that we have considered the problem from a new point of view.

There is no question but that the travelling belt type has marked advantages for coarse work, and we believe that we have overcome the former errors of construction, which may have prevented consideration by former possible customers.

With this construction we have an important novelty, consisting of a bobbin holder so arranged that the operative, when ready to put in a new bobbin, does not use time to pull out the empty bobbin, but simply pushes the new one into place, the empty bobbin passing through a gate at the rear of the bobbin holder, to fall down the chute onto the travelling belt. The illustration needs little explanation.

SPECIFICATIONS OF SPOOLERS

ORDERED FROM THE DRAPER COMPANY, HOPEDALE, MASS.

Name ..... Date..... 19.....
Place .....
Ship to .....Via what route.....
How many Spoolers? .....
Will you have the Travelling Belt Type? .....
Single or Double Rail Spindle? .....
How many Spindles in each? .....
Send sample Spindle, if top is to match others?.....
What length of traverse? .....
What gauge?.....
Bobbin Holders or Side Spindles?.....
Will you have Clark Bobbin Holder if ordering Traveling Belt? .....
Send Bobbin full of Yarn? .....
Specify number of Yarn to be Spooled?.....
Send Sample Spool?.....
What style of Guide?.....
Give Size of Spinning Ring used? .....
Will you have Bobbin Chutes (15 cents per Spindle extra)?.....
Will you have Spool Raising Device (25 cents per Spindle extra)? .....
Will you have Knot-tying Device (Extra charge for same)? .....
Will you have Top Creel? .....
Will you have Side Boxes or Shelves (If Shelves, give outside measurement of height and width of doffing boxes)? .....
Will you have Top Creel and Boxes made of Steel or Wood? ....
How Belted, from above or below? .....
Will you have 8″, 9″, 10″, 11″, 12″, 13″, 14″ or 15″ pulley, face 2″, 2¼″ or 2½″?.....
Shall Machines be Crated, Shod, or taken down and boxed?.. ..
Remarks.....
☞ In sending Spool, Spindle and Bobbin, please specify on same where from .....

With the introduction of large bobbins it will be well to experiment with speeds very carefully. Slow speeds at the spooler, warper and slasher all tend toward stronger, more elastic yarn, and less knots in the warp. Better warp tends to increase production at the loom and make better goods. We strongly advise against narrow economy as regards number of spooler spindles. Our spoolers will run as fast as any other, but that is not the question. We recommend the lowest speed table given on next page, with plenty of spooler spindles to do the work.

DIMENSIONS OF SPOOLERS.

Gauge	3½	3¾	4	4¼	4½	4¾	5	5¼	5½	5¾	6	6½
Diam. head of spool.	2¾	3	3¼	3½	3¾	4	4¼	4½	4¾	5	5¼	5¾
No of spindles.	Lengths in feet and inches.											
60	10 3	10 11	11 6	12 1	12 8	13 4	13 11	14 6	15 1	15 9	16 4	17 6
80	13 2	14 0	14 10	15 8	16 5	17 3	18 1	18 11	19 8	20 6	21 4	22 11
100	16 1	17 2	18 2	19 2	20 2	21 3	22 3	23 3	24 3	25 4		
120		20 3	21 6	22 9	23 11	25 2	26 5	27 8				
150				28 0	29 7							

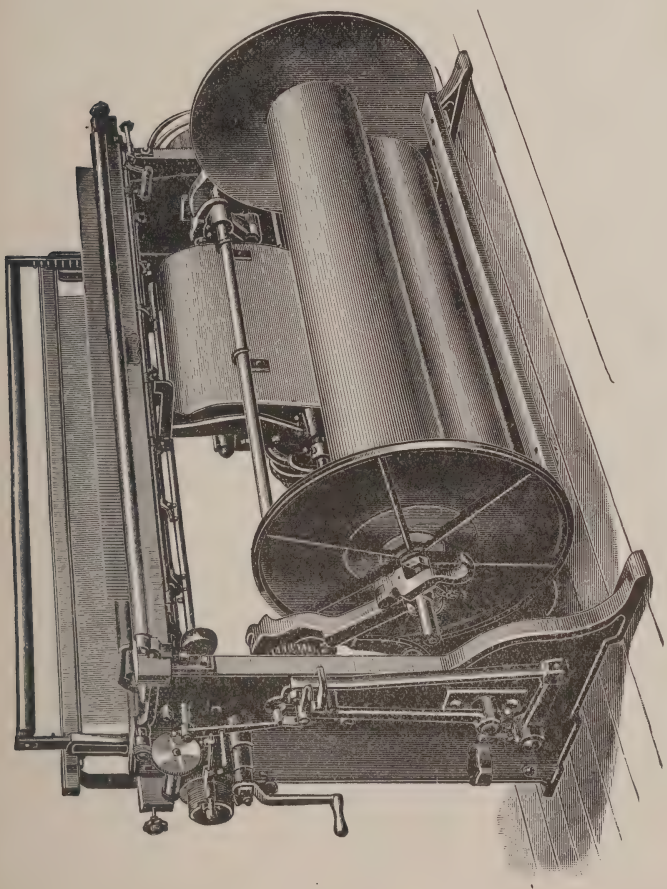
Width, including bobbin boxes, four feet.
Weight, from thirty to forty pounds per spindle complete.

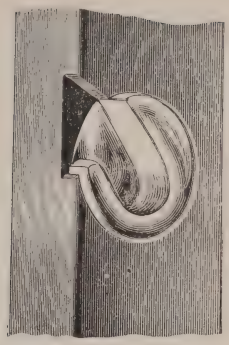
PRODUCTION OF SPOOLERS.

Dimensions of Spool.		Number of Yarn.	Revolutions per minute of the			Number of Rabbeth spindles to 1 spooler spindle, running at 825 revolutions per minute.
			Cylinder, 200. Spindle, 750.	Cylinder, 220. Spindle, 825.	Cylinder, 240. Spindle, 900.	
Length between heads.	Diam. of heads.		Pounds per spindle per week.			
6	5	8	64.3	70.7	77.1	
		10	51.4	56.6	61.7	
		12	42.9	47.1	51.4	12
		14	36.7	40.4	44.1	
		16	32.1	35.3	38.6	13
5	4	18	28.6	31.4	34.3	
		20	25.7	28.3	30.9	
		22	23.4	25.7	28.1	14
		24	21.4	23.6	25.7	
		26	19.8	21.8	23.7	
		28	18.4	20.2	22.0	15
		29	17.7	19.5	21.3	
		30	17.1	18.9	20.6	
		32	16.1	17.7	19.3	16
		34	15.1	16.6	18.1	
		36	14.3	15.7	17.1	
		38	13.5	14.9	16.2	17
4½	3½	40	12.9	14.1	15.4	18
		44	11.7	12.9	14.0	19
		50	10.3	11.3	12.3	20
3½	3¼	60	8.6	9.4	10.3	21
		70	7.3	8.1	8.8	23
		80	6.4	7.1	7.8	25

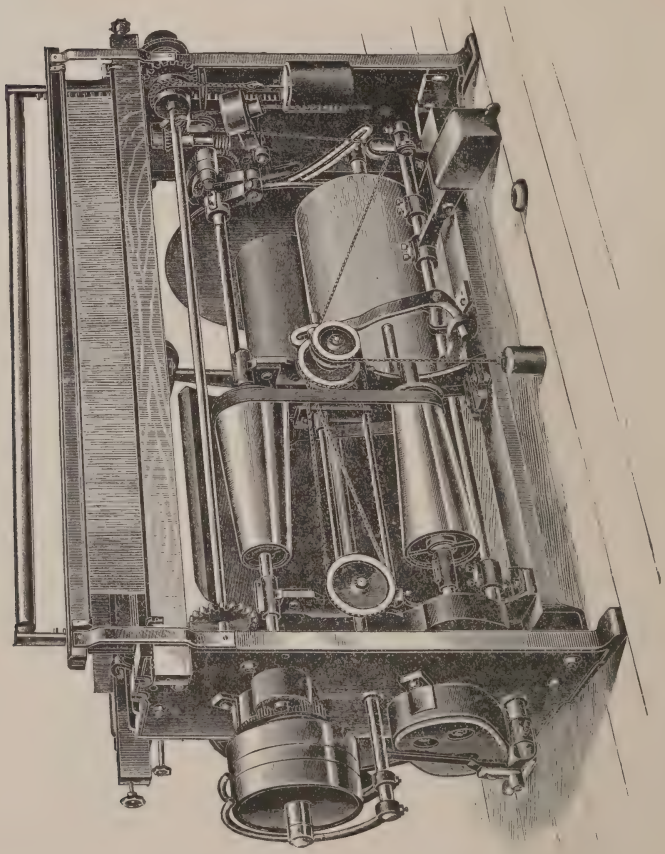
THE HOPEDALE SLASHER WARPER.

We still control the greater portion of the Warper trade in this country, notwithstanding recent increase in the number of our competitors. We have been the pioneers with every important warper improvement, and we have sufficient patent protection on our recent novelties to still distance the copyist. The nature of our complete complement of devices demands an increase in price, but to those with whom price is a first consideration, we can offer a simpler pattern of machine, which is still far superior in many details to those nearer its class.





A warper contains the generic idea of winding a beam of yarn from a creel full of spools. Starting with the creel, it is necessary to have it so arranged that a proper number of spools may be held in a convenient form for piecing up, without sacrificing too much space. The spool skewers should revolve in proper bearings. For fine yarn, there is nothing so neat and efficient as our patented glass step, clearly shown by the illustration. We furnish iron or wood bearings, if desired.



The yarns passing from the spools through the warper are first led through a separating comb, which has been modified in our later constructions. Our rise roll system has been greatly improved in recent years by the use of positive gearing, which takes the place of the old rope and scroll system. The roll must now move in a parallel path at all times, without any chance of bending and sticking. A rise roll is far preferable to a drop roll as it keeps the yarn up out of the dirt and saves one knot when piecing a broken end.

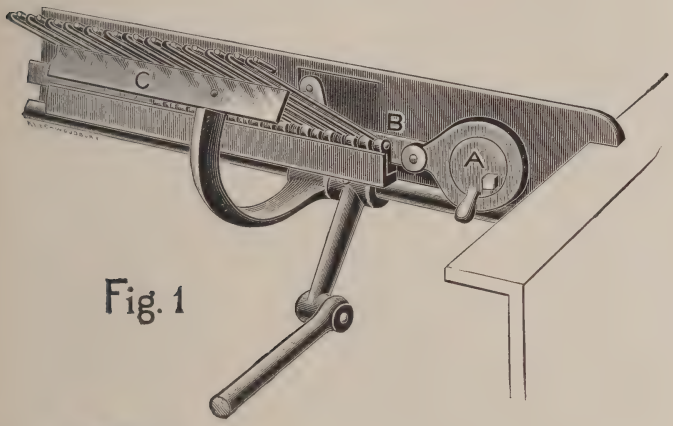


Fig. 1

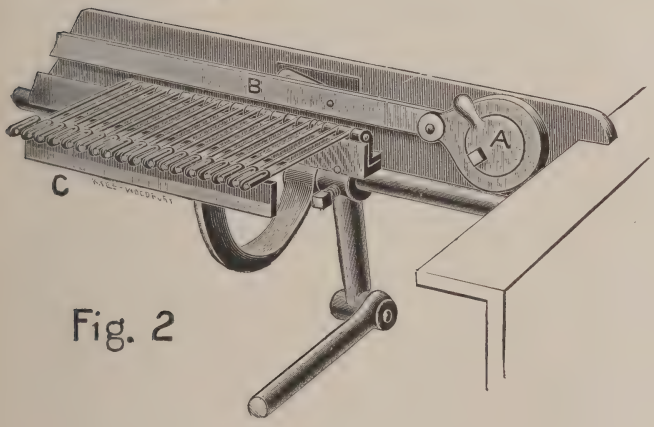


Fig. 2

Our stop motion is the Improved Walmsley, which involves the principle of a hinged wire, found in practice to be best adapted to the purpose, as it relieves the yarn of weight as compared with the drop wire system. It is also preferable in that the warper cannot be run with a broken end. With the

drop wire system, accidental removal of a wire will not be detected by the mechanism, and these wires have been known to be dragged into a warp by the yarn. Our locking-bar, with eccentric release, enables the removal of a group of wires at any point. Fig I. shows the locking bar in position and Fig. II shows it raised for the purpose of liberating the drops. The old system made it necessary to remove a large number of wires, when necessary to get at any damaged section. We can, of course, furnish any regular warp-stop motion in place of the Walmsley, if desired.

Our measuring rolls are now made of brass tubing, which is much more uniform in circumference than the average lot of tin rolls, and we surface them with a coat of paint to prevent the yarn from slipping.

The greatest change in principle of warping, in recent years, has come through the introduction of the Cone Drive, which enables the tension of the yarn to be kept uniform while winding the beam. This process enables a gain by either of two methods: If there is no wish to increase production, the even tension will result in less breakage at the warp, and also in the subsequent process of weaving; on the other hand, if more production is desired, the speed of winding can be considerably increased without straining the yarn more than with the uneven wind of the regular warper. We have sold hundreds of these attachments on our machines during the last nine years, so that the mechanism is quite well known.

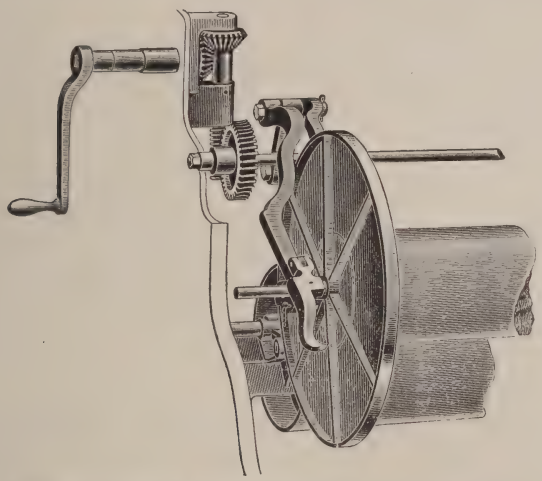
Power is applied to the winding drum of the warper through a pair of cones with a shifting cone belt, which is regulated automatically to vary the speed from the full to the empty spool, it being easily understood that the yarn winds off a full spool with a much less tension than off a nearly empty one. The belt automatically re-sets itself when a fresh beam is applied. As a usual warper spool has a yarn diameter varying from two to four inches, it is evident that when full it could warp twice as fast as when nearly empty, with no more strain on the yarn. The average speed would be, therefore, fifty per cent. greater than the speed of the common warper, which must be regulated by the highest strain. As a warper is stopped for tying in about a third of the time, the net gain is not fifty per cent., but nearer thirty-three per cent., if utilizing the full capacity of the drive. We recommend a slight reduction from this figure, or in proportion of four cone warpers to five common.

In equipping a new mill, the saving of floor space, and number of machines, is of course a most important item, but the effect on the yarn is, in our minds, of greatest value. Now that automatic weaving has come, every effort should be made to supply warps to the looms which will weave with the lowest

possible percentage of breakage. The fact that many breaks now happen on ordinary warps, proves that the tension is still too great for a certain percentage of the yarn, which proves that the yarn that does *not* break must also be strained more or less.

The Cone Drive cannot be conveniently attached to old warpers. Mills already equipped which desire to avail themselves of its advantages, can make terms with us by which new complete warpers can be purchased with a liberal allowance made for abandoned machines.

Another important new feature is our Low Cylinder, which has been used by us over six years, with universal satisfaction. By the use of an eccentric driving shaft, we overlap the center of the driving drum, enabling us to use a full 26-



inch beam head, and drive from a 12-inch cylinder. This feature may be noted in the cut showing the Beam Doffer. The advantage of this system is found in the possible change in design of the rest of the warper, enabling it to be made four inches lower and four and one-half inches narrower, so that the operative may tie in broken ends with greater ease; also allowing the use of smaller help.

Our Beam Doffer is another well appreciated idea, which originated with us, and which enables the operative to deliver a full beam from the warper to a truck without calling in the services of extra help. A simple crank movement, operating a train of gears, controls the warper beam, slowly lowering it to position on a truck, the new beam being raised into position by the same agency.

We have the simplest Slow Motion in the market. Our Reeds and Combs have important improvements, also, our present comb using a round wire, which presents a smoother surface for the yarn, the alternate wires being offset so as to give the threads perfect freedom of movement, even when the wires are quite closely together.

Another recent novelty is the Straw Registering Device, which detects the number of times the warper stops for broken threads, thus giving the overseer, or superintendent, an accurate daily record of the condition of the warp yarn, as made in the mill. The device necessarily consists of a dial and pointer, with operating connection. It is only applied on special order, as it involves an extra expense for royalty.

We wish it distinctly understood, that we are the only parties furnishing warpers with the Cone Drive, the Low Cylinder, the Geared Rise Roll, the Improved Walmsley Stop-Motion, the New Slow Motion, the Rhoades Warper Comb, the Straw Registering Device, and many other patented novelties.

When comparing with warpers of other makes, it must be remembered that our cheaper form of warper, which we sell to meet competitors' prices, still has the advantages of the Improved Walmsley Stop-Motion, Geared Rise Roll, New Slow Motion, and Improved Reeds and Combs. This machine has the ordinary large sized Drum, and Drop Rolls, if desired, in place of Rise Rolls. We can apply the Beam Doffer, if desired. We have an intermediate style using the Low Cylinder, without the Cone Drive, and we have the Cone Drive with the High Cylinder. Our complete and highest type of machine has all the improvements above noted.

SPECIFICATIONS OF SLASHER WARPERS,

ORDERED FROM THE DRAPER COMPANY, HOPEDALE, MASS.

For..... Date..... 190 ....

How many Warpers with driving pulleys on Right hand?.....

How many Warpers with driving pulleys on Left hand?.....

Large or small Cylinder?.....

(Small cylinder is best and takes larger beams than the large cylinder machine.) (Cannot have drop roll with small cylinder.)

Rise or Drop roll machine?.....

What length of Cylinder? (Our usual length is 54 inches.).....

Shall your Beam Heads be 18, 20, 21, 22, 23, 24 or 26 inches in diameter?.....

Diameter of barrel of Beams?.....

Largest number of Threads on Section Beam?.....

How many Raps, of 3000 yards each, on Beam?.....

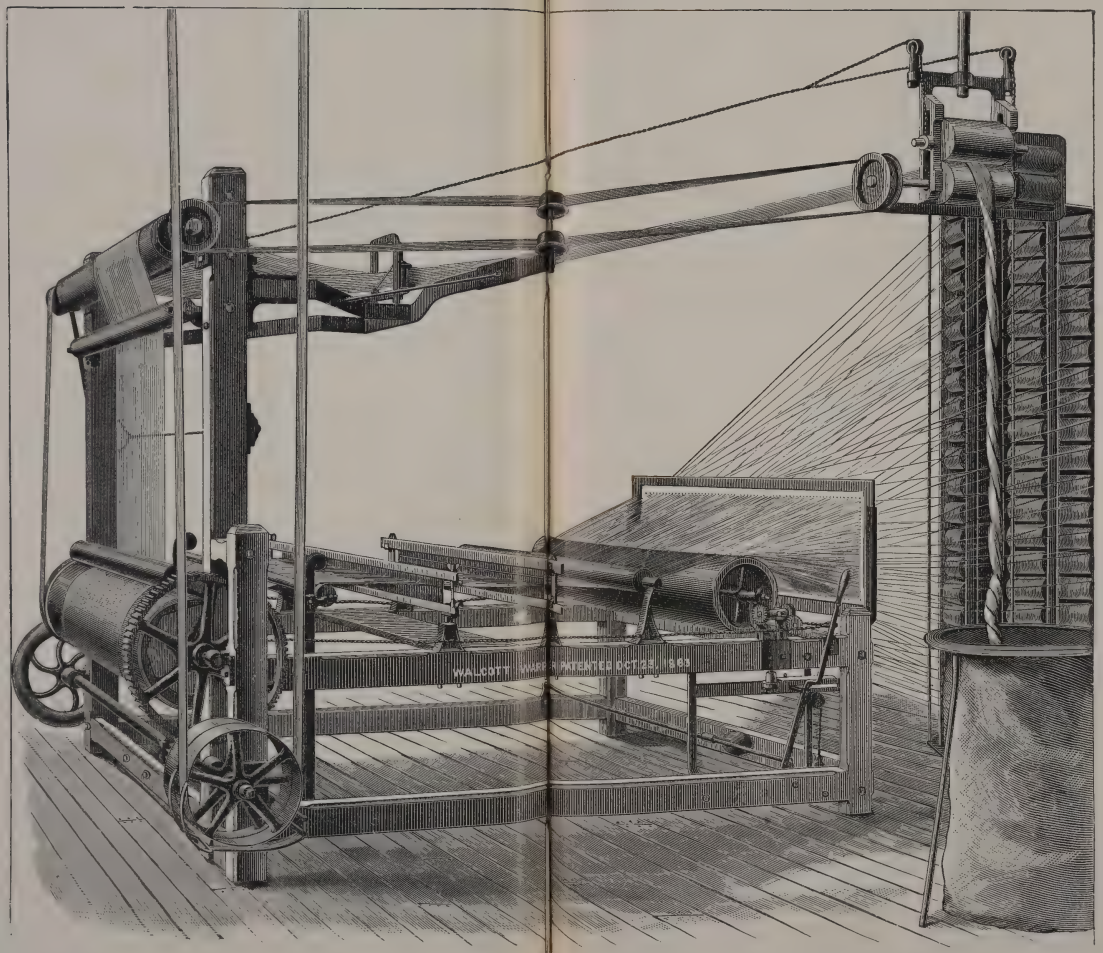
Will you drive the Beam with Threads over it or under?
Do you belt from above or below?
How many Section Beams?
How many V Creels?
What height is your room, floor to ceiling?
Will you have spool Bearings cut in the Standard?
Will you have Iron or Glass Creel Steps?
Send sample Spool, also Skewer, if used?
By what lines do you wish us to make shipment?
Do you want the Hicks Cone Drive?
Do you want the Beam Doffer?
Do you want a special Clock?
You cannot use the Beam Doffer with the Balling Motion.
☞ In sending samples, please specify where from.
Extra specification when Balling Motion is desired.
Do you want to wind balls?
What traverse for Balling Motion? (Regular size is 30 inches.)
Do you want Leasing Motion?
Remarks

DIMENSIONS OF WARPERS AND CREELS.

24 Inch Beam Heads. 12 Inch Cylinder.

Spools.	Head.	Trav.	High.	Long.	Width. FT.	Width. IN.	Length over all. FT.	Length over all. IN.
392	4	5	14	14	7	5	13	10
392	4	6	14	14	7	10½	14	4
392	5	6	14	14	8	4	14	10½
420	4	5	14	15	8	0	14	4
420	4	6	14	15	8	5½	15	0
420	5	6	14	15	8	11	15	6
450	4	5	15	15	8	0	14	4
450	4	6	15	15	8	5½	15	0
450	5	6	15	15	8	11	15	6
494	4	5	13	19	10	1	16	10½
504	4	5	14	18	9	7	16	3½
504	4	6	14	18	10	1½	16	11
510	4	5	15	17	9	0	15	8½
510	4	6	15	17	9	7	16	3½
512	4	6	16	16	9	0	15	7½
512	4	5	16	16	8	6	15	1
512	5	6	16	16	9	6	16	2½
520	4	5	13	20	10	7½	17	6
600	4	6	15	20	11	3	18	3
760	4	6	20	19	10	8	17	7

26 inch Beam Head would be 2 inches longer.
27 inch Beam Head would be 3½ inches longer.



WALCOTT CHAIN WARPER.

The 54-inch Cylinder Warper without creel occupies space of about 7 feet by 3 feet, 6 inches, for large cylinder, and about 7 feet by 3 feet, 1½ inches, for small cylinder.

Driving pulleys 10 in. diameter, 2 in. face.

Pulley on counter shaft should be 6 in. face to cover loose and slow motion pulleys on Warper.

Our beams are 54¼ in. between heads, with 9-inch barrel. For yarns up to 12's we recommend a beam with 26-inch heads; from 12's to 30's, 24-inch heads; 30's to 40's, 22 inch heads; and for numbers finer than 40's, 21-inch heads.

The following tabular statements will be found very nearly correct, and handy for reference in this connection.

Weight of yarn on a spool with barrel 1½ inches in diameter:—

With	5-inch	head,	6-inch	traverse,		1.9	lbs.
"	5	"	" 5	"	"	1.6	"
"	4	"	" 5	"	"	1.0	"
"	3½	"	" 4½	"	"	0.7	"

Weight of yarn on a beam, 54¼ inches between heads, and with a 9-inch barrel.

With	26-inch	heads,	420	lbs.
"	24	"	" 350	"
"	22	"	" 285	"
"	21	"	" 255	"

REEDS AND COMBS.

Our improved Expansion Warper Comb gives the best satisfaction to all who use it. We have often furnished them for other makes of warper.

A maximum number of ends in a 54-inch comb can be reduced 20 per cent. by the expansion apparatus. The Reed is formed by attaching a bar over the top of the wires of a comb, and expands or contracts to the same extent.

SPECIFICATIONS FOR REEDS AND COMBS.

We make three varieties of Warper Reeds or Combs.

1st. The front comb, or comb next to beam. This is open on top.

2d. The back comb. This is similar to the front comb, but has in addition a bar placed about 3 inches behind it to hold the ends from the upper half of the creel down between the wires.

3d. The back reed, which has a top-rail directly over and covering the tops of the wires. We make two kinds of back reeds, the "high" and the "low." The "high" reed measures 5 inches from top of case to underside of hand rail. The "low" reed measures 3 inches from top of case to underside of top rail.

DIRECTIONS FOR ORDERING.

How many front combs	Highest No. ends	Length Cyl.
How many back combs	Highest No. ends	Length Cyl.
How many back reeds.	Highest No. ends	Length Cyl.

Our usual length of box for either reeds or combs, is 71 inches; if any other length is wanted please specify.

REMARKS.

Do you have a carrier roll between front comb and beam?

Do you have a carrier roll between back reed or comb and the rising or falling roll?

IMPROVED CUT MARKERS FOR SLASHERS.

The Rolfe Cut-Marker has been in use a number of years, and has given good satisfaction. Its motion is positively obtained by gearing, without wire or springs. It does not waste or splash the marking ink, and is liked by all who use it. It marks the wet yarn between the size box and drying cylinder; the mark is therefore dried in with the sizing, and can neither be rubbed off or transferred to other layers of yarn on the beam. The mark is neat and well defined, and cannot be used as an excuse for making short cuts.

Send for prices.

The following tables show the number of pounds warped on a Hopedale Slasher Warper, per week of sixty hours, at different speeds of cylinder and for different numbers of ends and sizes of yarn. In these tables the actual amount warped is assumed to be two-thirds of the theoretical amount. In figuring for a Cone Warper, take the average speed of cylinder from empty to full beam.

Rule for finding the number of pounds of yarn on a beam.

Multiply the sum of the diameters of the barrel and beam heads by the difference of their diameters, then multiply by .7854, and then multiply by the length between the heads, giving the cubic inches of yarn on the beam when full. For instance, with a beam 9″ barrel and 24″ head, and 54¼″ between heads:

$9+24\times15\times.7854\times54\frac{1}{4} = 21090.935+$ cubic inches yarn in full beam.

$21090.935\div60 = 351+$ (pounds).

To get the length of the yarn on beam, multiply number of yarn by 840, which gives the number of yards in one pound, then multiply by number of pounds of yarn in beam. Divide the product by number of ends run in warper to find the length of warp.

WARPER TABLES.

I. REVOLUTIONS PER MINUTE OF CYLINDER, 30; PULLEYS, 163.

Number of ends.	260	300	320	340	360	380	410	440
Number of yarn.	Pounds warped in sixty hours.							
8	4,179	4,821	5,143	5,465	5,786	6,107	6,589	7,071
10	3,343	3,857	4,114	4,372	4,629	4,886	5,271	5,657
12	2,786	3,214	3,429	3,643	3,857	4,071	4,393	4,714
14	2,388	2,755	2,939	3,123	3,306	3,490	3,765	4,041
16	2,089	2,411	2,571	2,733	2,893	3,053	3,295	3,535
18	1,857	2,143	2,285	2,429	2,571	2,714	2,929	3,143
20	1,671	1,928	2,055	2,186	2,314	2,443	2,636	2,829
22	1,519	1,753	1,870	1,987	2,104	2,221	2,396	2,571
24	1,393	1,607	1,714	1,821	1,929	2,036	2,197	2,357
26	1,286	1,483	1,582	1,681	1,780	1,879	2,027	2,176
28	1,194	1,377	1,469	1,561	1,653	1,745	1,883	2,021
29	1,152	1,330	1,418	1,507	1,596	1,685	1,818	1,950
30	1,114	1,285	1,371	1,457	1,543	1,629	1,757	1,885
32	1,044	1,205	1,285	1,346	1,447	1,527	1,647	1,768
34	983	1,135	1,210	1,286	1,361	1,437	1,551	1,664
36	929	1,071	1,143	1,214	1,286	1,357	1,464	1,571
38	880	1,015	1,083	1,150	1,218	1,285	1,387	1,489
40	836	964	1,029	1,093	1,157	1,221	1,318	1,414
44	760	877	935	993	1,051	1,110	1,198	1,286
50	669	771	823	874	926	977	1,054	1,131

II. REVOLUTIONS PER MINUTE OF CYLINDER, 33; PULLEYS, 180.

Number of ends.	260	300	320	340	360	380	410	440
Number of yarn.	Pounds warped in sixty hours.							
8	4,597	5,303	5,657	6,011	6,365	6,718	7,248	7,773
10	3,677	4,243	4,525	4,809	5,091	5,375	5,799	6,223
12	3,065	3,535	3,771	4,007	4,243	4,479	4,832	5,185
14	2,627	3,030	3,233	3,435	3,637	3,839	4,142	4,445
16	2,298	2,652	2,829	3,006	3,182	3,359	3,624	3,889
18	2,043	2,357	2,514	2,671	2,829	2,985	3,221	3,457
20	1,839	2,121	2,263	2,405	2,546	2,687	2,899	3,111
22	1,671	1,929	2,057	2,186	2,315	2,443	2,635	2,829
24	1,532	1,768	1,885	2,003	2,121	2,239	2,416	2,587
26	1,415	1,631	1,740	1,849	1,958	2,067	2,230	2,393
28	1,313	1,515	1,616	1,717	1,818	1,919	2,070	2,223
29	1,268	1,463	1,560	1,658	1,755	1,853	2,000	2,146
30	1,225	1,414	1,509	1,603	1,697	1,791	1,933	2,074
32	1,149	1,326	1,414	1,503	1,591	1,679	1,812	1,945
34	1,081	1,248	1,331	1,415	1,497	1,581	1,706	1,831
36	1,021	1,179	1,257	1,335	1,415	1,493	1,611	1,729
38	968	1,117	1,191	1,265	1,340	1,414	1,526	1,637
40	919	1,061	1,131	1,202	1,273	1,343	1,450	1,555
44	836	964	1,029	1,093	1,157	1,221	1,318	1,415
50	735	849	905	961	1,019	1,075	1,159	1,245

WARPER TABLES. — *Continued.*

III. REVOLUTIONS PER MINUTE OF CYLINDER, 36; PULLEYS, 196.

Number of ends.	260	300	320	340	360	380	410	440
Number of yarn.	Pounds warped in sixty hours.							
8	5,015	5,785	6,171	6,557	6,943	7,329	7,907	8,485
10	4,011	4,629	4,937	5,246	5,555	5,863	6,325	6,789
12	3,343	3,857	4,181	4,372	4,629	4,885	5,271	5,657
14	2,865	3,305	3,527	3,747	3,967	4,188	4,519	4,849
16	2,507	2,893	3,085	3,279	3,471	3,664	3,953	4,243
18	2,229	2,571	2,743	2,915	3,085	3,257	3,515	3,771
20	2,005	2,315	2,468	2,623	2,777	2,931	3,163	3,395
22	1,823	2,104	2,244	2,385	2,525	2,665	2,875	3,085
24	1,671	1,925	2,057	2,185	2,315	2,443	2,636	2,829
26	1,543	1,780	1,899	2,017	2,136	2,255	2,433	2,611
28	1,433	1,653	1,763	1,873	1,983	2,094	2,259	2,425
29	1,383	1,596	1,703	1,809	1,915	2,021	2,181	2,341
30	1,337	1,543	1,645	1,749	1,851	1,955	2,109	2,263
32	1,253	1,447	1,543	1,639	1,736	1,832	1,977	2,121
34	1,180	1,361	1,452	1,543	1,633	1,725	1,861	1,997
36	1,115	1,285	1,371	1,457	1,543	1,629	1,757	1,885
38	1,056	1,219	1,299	1,380	1,461	1,543	1,665	1,787
40	1,003	1,157	1,235	1,311	1,389	1,465	1,581	1,697
44	912	1,052	1,123	1,192	1,262	1,332	1,437	1,543
50	806	925	987	1,049	1,111	1,171	1,265	1,357

IV. REVOLUTIONS PER MINUTE OF CYLINDER, 40; PULLEYS, 218.

Number of ends.	260	300	320	340	360	380	410	440
Number of yarn.	Pounds warped in sixty hours							
8	5,571	6,428	6,857	7,286	7,715	8,143	8,785	9,428
10	4,457	5,142	5,485	5,828	6,171	6,515	7,028	7,543
12	3,715	4,285	4,571	4,857	5,143	5,428	5,857	6,285
14	3,184	3,673	3,918	4,163	4,408	4,653	5,020	5.387
16	2.785	3.214	3,428	3,643	3,857	4,071	4,393	4,713
18	2.476	2,857	3,047	3,238	3,428	3,619	3,905	4,190
20	2,228	2,571	2,742	2,915	3,086	3,257	3,515	3,771
22	2,025	2,337	2,493	2,649	2,805	2,961	3,195	3,428
24	1,857	2,143	2,285	2,428	2,571	2,715	2,929	3,143
26	1,715	1,977	2.109	2,241	2,373	2,505	2,703	2,901
28	1,592	1,836	1,959	2,081	2,203	2,326	2,510	2,694
29	1,537	1,773	1,891	2,009	2,128	2,246	2,424	2,600
30	1,485	1,713	1,828	1,943	2,057	2,171	2,343	2,513
32	1,393	1,607	1,713	1,821	1,929	2,035	2,196	2,357
34	1,311	1,513	1,613	1,715	1,815	1,916	2,067	2,219
36	1,238	1,428	1,523	1,619	1,714	1,809	1,952	2,095
38	1,173	1,353	1,443	1,533	1,624	1,713	1,849	1,985
40	1,115	1,285	1,371	1,457	1,543	1,628	1,757	1,885
44	1,013	1,169	1,247	1,324	1,403	1,480	1,597	1,715
50	892	1,028	1,097	1,165	1,235	1,303	1,405	1,508

THE WALCOTT CHAIN WARPER.

See cut on pages 200-201.

In the light of modern education on these matters, it is useless to explain the advantages of a chain warper over the old-fashioned method of winding chain warps on a reel.

This machine of ours has none of the limits of the old-fashioned methods, being able to produce a chain of any length, with anywhere from 500 to 1200 ends. While we could, of course, construct a warper for more ends, we do not believe there is any economy in running over 1200 ends from one creel, as the extra time required for banking and tying in spools and the necessary stops for piecing up, reduces the amount of production in a given time, thereby increasing its cost very materially.

In late years we are applying our Walmsley stop motion very successfully to this style of warper, and have also made minor improvements in general details.

The stop motion is not shown in the cut herein illustrated. The complete warper and creel for 1200 spools and receiving bag and position for the operator, occupies a space of about sixteen feet by thirty-two feet: two feet longer with stop motion: eight and one-half feet high. One machine will do more and better work, than three reel or upright warpers.

This claim is made without distinction of coarse or fine numbers, small or large chains. They are in use in mills in every section of the country, and we can refer to users if necessary.

Specification blank furnished on application.

AUTOMATIC LINKER.

We have a very satisfactory mechanism for linking long chains which makes links of uniform length which are easily pulled out, and not liable to become tangled.

SPECIFICATION FOR WALCOTT CHAIN WARPERS.

ORDERED OF THE DRAPER COMPANY, HOPEDALE, MASS.

For .....

..... 1900

Number of chain warpers with driving pulleys on right hand side .....

Number of chain warpers with driving pulleys on left hand side .....

Number of ends to be run in each warper .....

Number of deliveries for each warper .....

Delivery and operator's position to be at (right or left) hand .....

Thread lease .....

Pin lease for how many ends in a pin? .....

Number of yarn to be run in each warper .....

Number of yards in each cut .....

Number of cuts in each chain .....

Walmsley stop-motion .....

Number of adjustable V creels (Send sample spool marked with name of mill if creels are wanted.) .....

Skewer bearings cut in creel stile .....

Creel steps (of iron or glass) .....

Ship (in crates or taken down and boxed) .....

Do you want Linkers? .....

State distance between floors, as delivery is attached to floor above; or if delivery is to be attached to beams or stringers, state distance from floor up to them .....

Ship via .....

Remarks .....

See illustration for arrangement of spools in creels for different numbers of ends, with floor space required for creels with different sizes of spools.

Length of warper frame, 10 feet, with stop-motion, 12 feet.

Space between holey board and creel, about 2 feet 6 inches.

Space between spools in creels, 18 and 20 spools high, $\frac{3}{4}$ inch; 14 and 16 spools high, 1 inch.

Holey board and lease reeds are 46 inches wide, and made to correspond with number of ends in creel.

If skewers are used they should be 1 1-16 inch longer than spools.

Driving pulley 10 inches in diameter for 2 inch belt.

DIMENSIONS OF CREELS FOR WALCOTT CHAIN WARPER.

No. of Ends.	No. Spools High.	No. Spools Long.	7½″ RUN, to carry spools with 3½″ h'd, 4½″ traverse			8″ RUN, to carry spools with 4″ head, 5″ traverse.			8½″ RUN to carry spools with 4″ head, 6″ traverse.			9″ RUN, to carry spools with 5″ head, 6″ traverse.		
			L'gth.	Width.	Height	L'gth.	Width.	Height	L'gth.	Width.	Height	L'gth.	Width.	Height.
1200	20	30	17′ 8″	15′ 1″	7′ 4¼″	18′ 9″	16′	8′ 2½″	19′ 11″	16′ 10″	8′ 2½″	21′	17′ 9″	9′ 10½″
1160	20	29	17′ 1″	14′ 8″	7′ 4¼″	18′ 2″	15′ 6″	8′ 2½″	19′ 3″	16′ 4″	8′ 2½″	20′ 4″	17′ 2″	9′ 10½″
1120	20	28	16′ 6″	14′ 2″	7′ 4¼″	17′ 7″	15′	8′ 2½″	18′ 7″	15′ 10″	8′ 2½″	19′ 8″	16′ 8″	9′ 10½″
1080	18	30	17′ 8″	15′ 1″	6′ 8″	18′ 9″	16′	7′ 5″	19′ 11″	16′ 10″	7′ 5″	21′	17′ 9″	8′ 11″
1044	18	29	17′ 1″	14′ 8″	6′ 8″	18′ 2″	15′ 6″	7′ 5″	19′ 3″	16′ 4″	7′ 5″	20′ 4″	17′ 2″	8′ 11″
1008	18	28	16′ 6″	14′ 2″	6′ 8″	17′ 7″	15′	7′ 5″	18′ 7″	15′ 10″	7′ 5″	19′ 8″	16′ 8″	8′ 11″
972	18	27	15′ 11″	13′ 9″	6′ 8″	16′ 11″	14′ 6″	7′ 5″	17′ 11″	15′ 4″	7′ 5″	18′ 11″	16′ 1″	8′ 11″
960	16	30	17′ 8″	15′ 1″	6′ 3½″	18′ 9″	16′	6′ 11½″	19′ 11″	16′ 10″	6′ 11½″	21′	17′ 9″	8′ 3½″
928	16	29	17′ 1″	14′ 8″	6′ 3½″	18′ 2″	15′ 6″	6′ 11½″	19′ 3″	16′ 4″	6′ 11½″	20′ 4″	17′ 2″	8′ 3½″
896	16	28	16′ 6″	14′ 2″	6′ 3½″	17′ 7″	15′	6′ 11½″	18′ 7″	15′ 10″	6′ 11½″	19′ 8″	16′ 8″	8′ 3½″
864	16	27	15′ 11″	13′ 9″	6′ 3½″	16′ 11″	14′ 6″	6′ 11½″	17′ 11″	15′ 4″	6′ 11½″	18′ 11″	16′ 1″	8′ 3½″
840	14	30	17′ 8″	15′ 1″	5′ 6½″	18′ 9″	16′	6′ 1½″	19′ 11″	16′ 10″	6′ 1½″	21′	17′ 9″	7′ 3½″
812	14	29	17′ 1″	14′ 8″	5′ 6½″	18′ 2″	15′ 6″	6′ 1½″	19′ 3″	16′ 4″	6′ 1½″	20′ 4″	17′ 2″	7′ 3½″
784	14	28	16′ 6″	14′ 2″	5′ 6½″	17′ 7″	15′	6′ 1½″	18′ 7″	15′ 10″	6′ 1½″	19′ 8″	16′ 8″	7′ 3½″
756	14	27	15′ 11″	13′ 9″	5′ 6½″	16′ 11″	14′ 6″	6′ 1½″	17′ 11″	15′ 4″	6′ 1½″	18′ 11″	16′ 1″	7′ 3½″
728	14	26	15′ 4″	13′ 3″	5′ 6½″	16′ 3″	14′ 1″	6′ 1½″	17′ 3″	14′ 9″	6′ 1½″	18′ 3″	15′ 6″	7′ 3½″
700	14	25	14′ 9″	12′ 10″	5′ 6½″	15′ 8″	13′ 7″	6′ 1½″	16′ 7″	14′ 3″	6′ 1½″	17′ 6″	15′	7′ 3½″
672	14	24	14′ 2″	12′ 4″	5′ 6½″	15′ 1″	13′ 1″	6′ 1½″	15′ 11″	13′ 9″	6′ 1½″	16′ 10″	14′ 5″	7′ 3½″
644	14	23	13′ 7″	11′ 11″	5′ 6½″	14′ 5″	12′ 7″	6′ 1½″	15′ 3″	13′ 3″	6′ 1½″	16′ 2″	13′ 11″	7′ 3½″
616	14	22	13′	11′ 6″	5′ 6½″	13′ 9″	12′ 1″	6′ 1½″	14′ 7″	12′ 9″	6′ 1½″	15′ 5″	13′ 4″	7′ 3½″
588	14	21	12′ 5″	11′	5′ 6½″	13′ 2″	11′ 7″	6′ 1½″	13′ 11″	12′ 3″	6′ 1½″	14′ 9″	12′ 10″	7′ 3½″

THE DRAPER BALLING MACHINE.

In the process of chain warping, two well-known methods are in use. Some mills find it convenient, or necessary, to make chains containing up to 1400 ends, and others use a chain with 500 or less. No one machine can properly be adapted to both methods, so that in running on a small number of ends, a Balling Machine is almost universally employed. Modern practice strongly favors the long chain system with the smaller number of ends.

We believe we have the simplest, cheapest and most economical machine for doing this work, producing the best results with the least possible labor and expense, by combining our well-known Slasher Warper with our Improved Balling Machine and the Straw leasing motion and clock.

With these arrangements we are enabled to wind balls weighing as high as 250 pounds or more, without any slack threads, and with a thread lease taken at convenient intervals. This process is extensively used in many of our best mills and gives entire satisfaction. Two smaller balls can be wound at one time on the same machine by slight modification in the mechanism.

The operation of the machine is very simple, the thread being taken from spools in the usual creel, through the regular warper to the front comb, where the Straw leasing motion is applied. After passing through this the ends are brought together in a trumpet, and carried over the pulley in chain form back to a traverse guide, which winds a ball on the same principle used in the traverse of a card grinder, although with different details of construction.

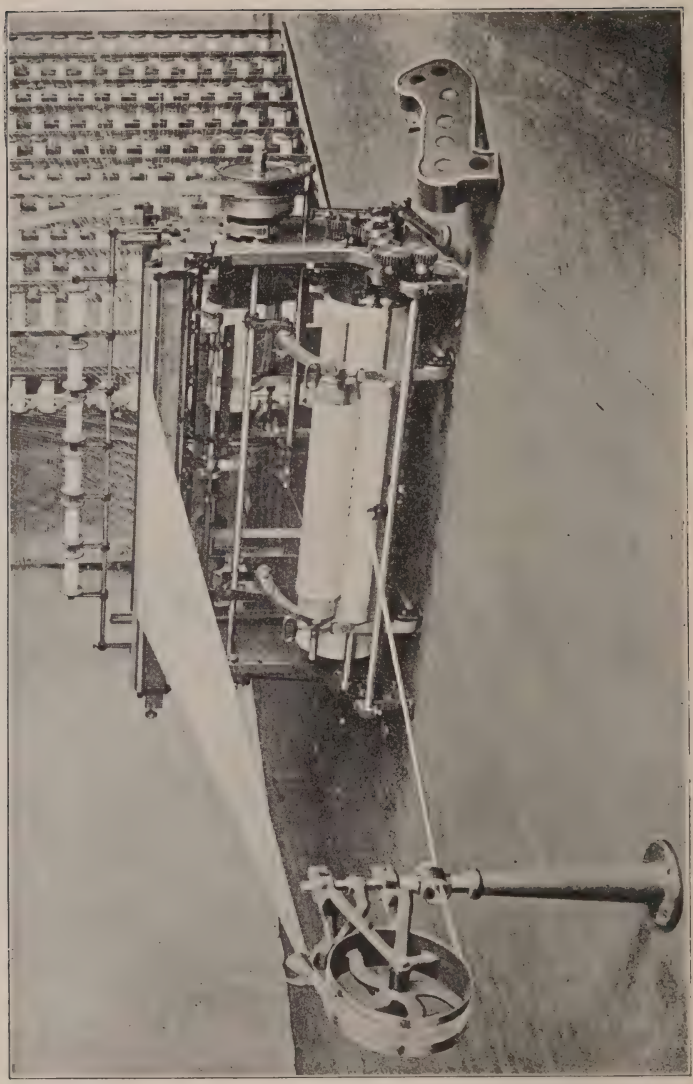
The warper clock is adapted for stopping the machine so that a thread lease can be taken at any point in the chain that may be required.

Our cuts show the very latest construction from recent photographs.

Our warper itself has been modified in detail, but the principle change is that of driving the roller or ball, as wound on the roller, by contact with two cylinders or drums, thus preventing any slipping, and winding a more compact ball.

As compared with competing machines for the purpose, we get an advantage in floor space and general convenience, and we also use less parts and less complication.

As to the warper itself, it is well known that our form contains more recent improvements than any other, and the fact that it controls the market for at least three-quarters of the demand, is sufficient testimonial to its merits.



DRAPER BALLING MACHINE ON SMALL CYLINDER WARPER.

PRODUCTION OF BALLING MACHINES.

It is almost impossible to give any figures of value as a guide to those intending to figure possible product, as the balls vary so in number of ends, length, and number of yarn balled.

The usual speeds of the driving drum or roll give a surface speed for the ball of from 50 to 60 yards per minute. It is safe to allow 25 per cent. or more for loss of time.

Our machine will of course produce as much as any other of the same general design.

We make balling machines in two styles—one driven from the warper cylinder and auxiliary roll, and the other driven by a small pair of rolls geared directly to the warper, dispensing with the cylinder.

We make our rolls shell or solid as desired.

SPECIFICATIONS OF BALLING MACHINES,

ORDERED FROM THE DRAPER COMPANY, HOPEDALE, MASS.

For ..... Date ..... 190.....
How many for Right Hand Warper .....
How many for Left Hand Warper .....
How many Balls to be wound on one machine, (One or two) ....
What Model of machine (See back) .....
What length of Traverse, (Regular size 30 inches) .....
How many Wood Rolls ..... Shell or Solid ..... (See back.)
Clock to stop every ..... yards .....
Register to register up to ..... yards .....
How many Leasing Motions Right Hand .....
How many Leasing Motions Left Hand .....
How many Ends .. .. on ..... inches.
What make of Warper is Balling machine to be applied to .....
Length of Cylinder .....
Diameter of Cylinder .....
Diameter of Measuring Roll .....
Diameter of Measuring Roll Shaft for Clock Worm .....
Distance between Ribs of Warper Sides .....
Diameter of Beam Arm Girt .....
Diameter of Cylinder Gear .....
No. of Teeth in Cylinder Gear .....
Distance beween Cylinder Gear and Warper Side .....
☞ In sending samples, please specify where from.
Remarks .....

A NEW PROCESS IN CHAIN DYEING.

All manufacturers of colored goods, the yarns for which are bleached or dyed before using, are only too familiar with the constant annoyance and expense caused by the snarling and breaking of the yarn in the various processes of the dye house.

Since the introduction of chain quilling machines, by far the largest part of cotton yarns, both warp and filling, have been colored in the chain which, notwithstanding all its drawbacks, has been found on the whole the most economical method.

The most difficult and unsatisfactory process in all manufacturing has hitherto been the rewinding or beaming of the colored or bleached chains after they are returned from the dye house.

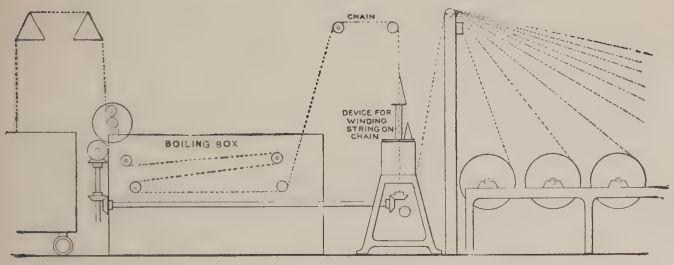
No one familiar with the manufacture of colored goods needs to be reminded of the endless number of broken and snarled chains, slack threads and twisted selvages, which are continually turning up in the beaming room, however carefully the dye house is managed.

There has long been an urgent need for some process or method by which the excessive damage done to chains in the dye house might be avoided, and the following processes of manufacture be thus rendered less difficult.

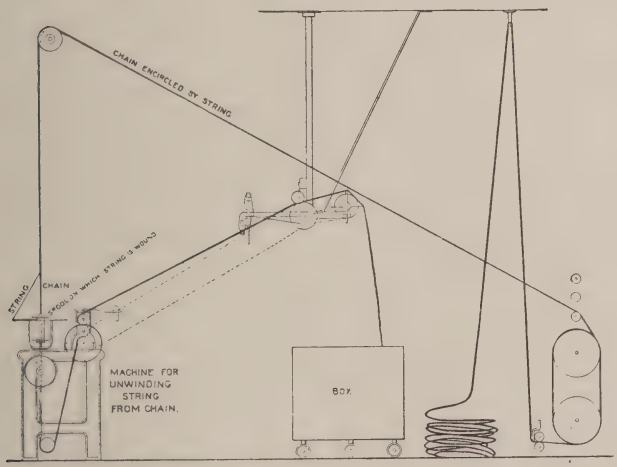
This need has at length been supplied, and we are prepared to furnish methods and machines by the use of which the snarling and breaking of chains in the dye house can be practically entirely prevented.

Several years ago a Mr. Henry Gildard, employed at the time in one of our large colored mills, conceived the idea of winding or coiling around each chain from end to end a cord of suitable strength to hold the various threads together and prevent snarling and breaking in the dye house. The patents taken out by him are in our hands, together with supplementary patents of Mr. Herman F. Straw of the Amoskeag Mfg. Co., covering mechanical methods of unwinding the cord from the chain.

We believe we are well within bounds when we say that a net saving of at least one-half the whole cost of rebeaming may readily be made in the dressing room alone, and the gain in the weaving rooms, from the greatly improved preparation and the absence of knots and twists, should be nearly as much more.



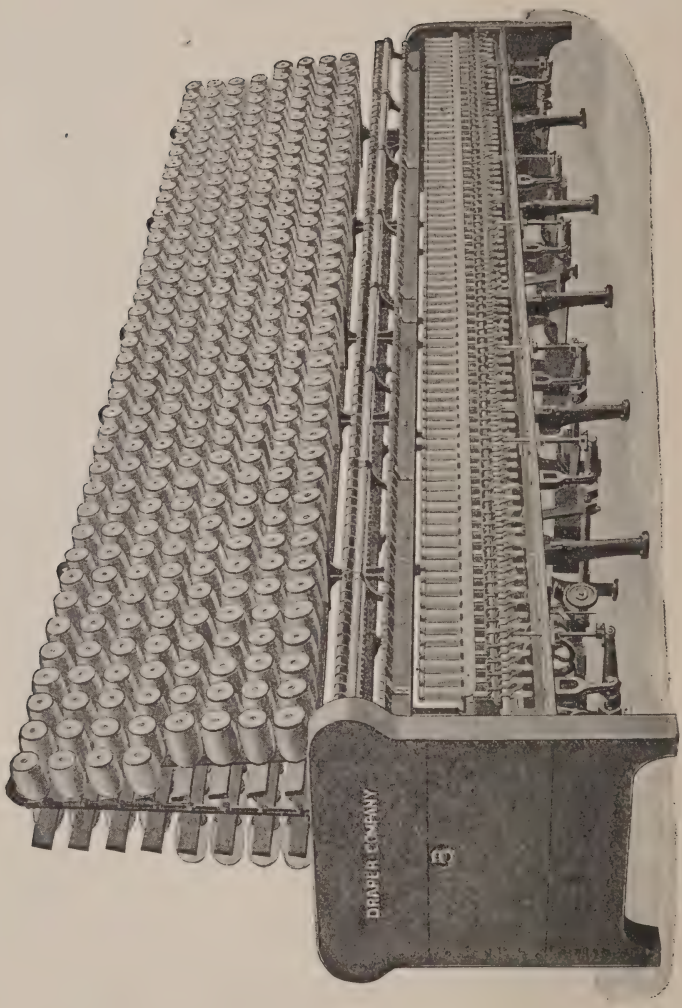
This system of chain dyeing, including both the winding and unwinding process, is already in use by the principal mills that use colored warps, so that the field for further sales is somewhat limited.



The sketches we show in rough detail may help to give an idea of how the machines are used.

We have seldom introduced an idea that won so prompt a recognition and gave so large a return on the capital invested. It certainly ranks with the most important of recent textile inventions.

Any one wishing to investigate this process, would do well to communicate with us, and we can send our expert to talk the matter over with them.



OUR LATEST TWISTER.

THE HOPEDALE TWISTER.

The increasing demand for this style of machine has prompted us to bring out an entirely new design, of which large orders have already been filled, giving the test of approval and taking it out of the experimental field.

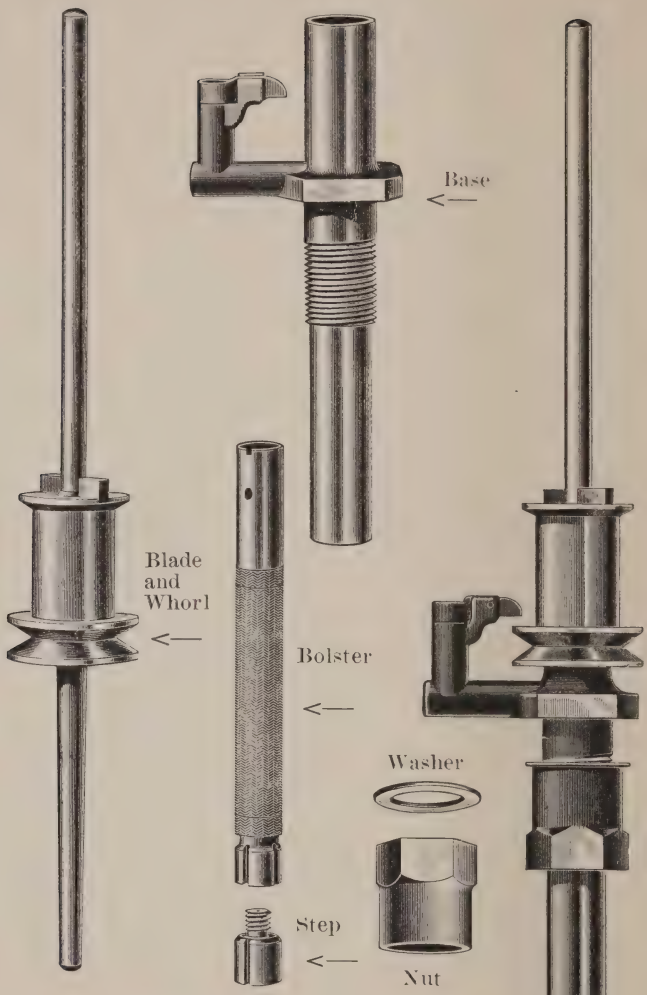
We have aimed to strengthen and solidify wherever possible, as we realize that twisters built to-day may be required to stand a service the nature of which our present manufacturers hardly comprehend. To speak more plainly, we have knowledge of certain experiments destined for application on this class of machinery, which may enable the speed to be greatly increased with corresponding saving and advantages. Such improvement, however, will have no value for those whose old machinery is not fitted for the strain and wear incurred by higher speed. Inasmuch as the question of price is not affected, it behooves the purchaser to select the best in any event, and we cheerfully ask comparison with any twister ever made.

The cut shows the general appearancee of the new machine. The cover at the head end is a noticeable feature, the gearing being protected by removable sections, all of which may be taken off without removing a bolt or screw, automatic locking devices holding the three pieces in place.

The rails are of heavy box pattern and the samsons are adapted to be set to accommodate a varying level in the floor, the adjustment being positive and capable of most accurate adjustment by use of screw and nut, as shown. Extra metal has been put in wherever weight would add to stiffness. The frame work of the machine, however, is but a skeleton to which are attached the vital parts.

SPINDLES.

Taking these in turn, we come first to the spindles, which are made in our own works, under a system of gauging and inspection which has been evolved by years of thought and experience. We have had great success in adapting our spinning spindle design of bolster and step to twister spindles, allowing the advantages of the adjustable bolster fit, which has gone into such extensive use in the 49D and Draper types. The use of the packed bolster on twisting spindles has been found of great value on high speeds, enabling steadier running and showing marked results on the finer grades of yarn.

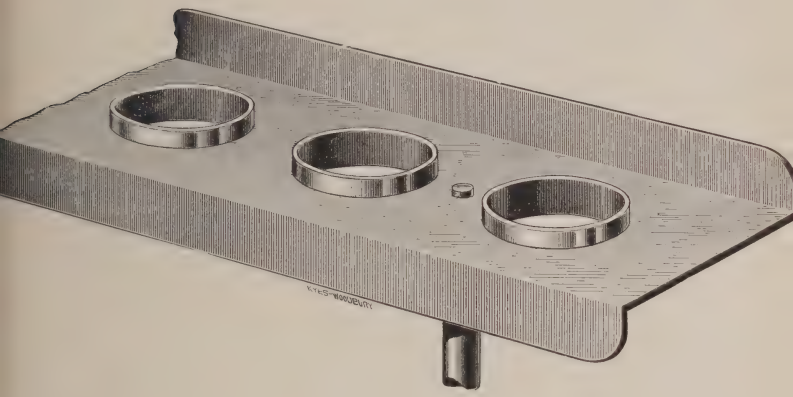


TWISTER SPINDLE PARTS.

1. Blade.
2. Whorl.
3. Oil retainer underneath whorl.
4. Bolster.
5. Packing.
6. Packing Strings.
7. Step.
8. Base.
9. Spindle retainer.
10. Locking pins, two used.
11. Pin to hold on spindle retainer.
12. Washer.
13. Nut.

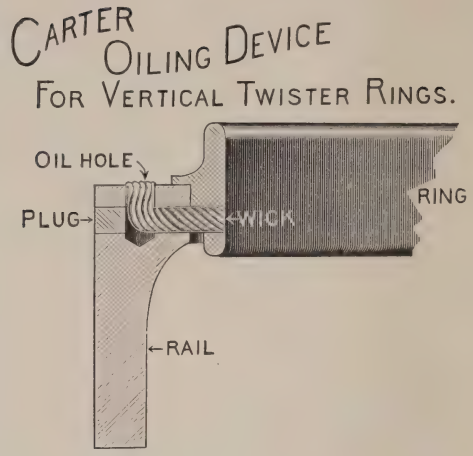
The Woodmancy doffer guard is used on all our spindles, it having universal recommendation.

It is useless to waste any time in arguing for the merits of the modern high speed spindle against the old common type. While in certain twisting, the speed of the frame is perhaps low enough to allow the use of a common type, in very limited instances, it will not do for manufacturers to be handicapped by spindles that cannot bear increase of speed, providing improvements are developed which would allow an increase in speed.

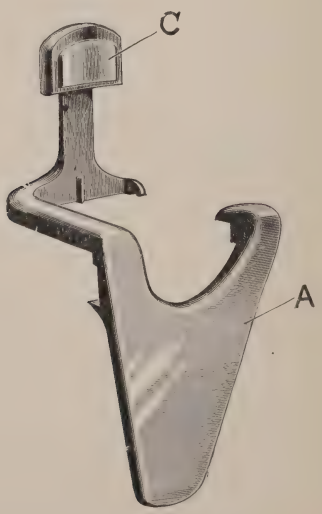


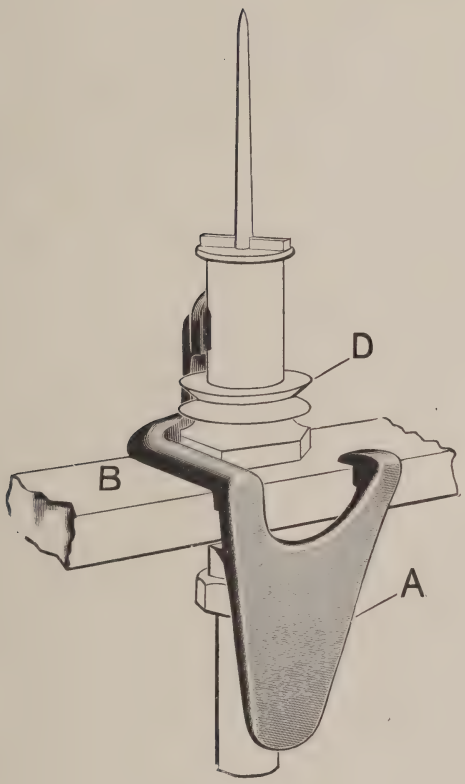
RINGS.

We manufacture all our own rings from our own drop forgings, and can guarantee them in every particular. We make all the standard styles, and have certain improved novelties which no other builder can furnish. Our patent combined vertical ring and ring rail for wet twisting has met with universal success. As shown in the cut, its use allows the rings to be made reversible for double wear by simply turning the rail over. Being made of smooth continuous stock, it is easy to clean or wash, and the flanges make it stiff beyond any possible requirements. We add extra weight to the flanges in cases where the pull on the rings through the yarn necessitates greater steadiness. The cut is self explanatory.



The Carter Self-oiling Ring is another important improvement for vertical rings of three inches in diameter or over. The invention consists in the application of a wick, which lubricates the traveller below its contact with the yarn, allowing the speed to be increased from fifteen to twenty-five per cent.

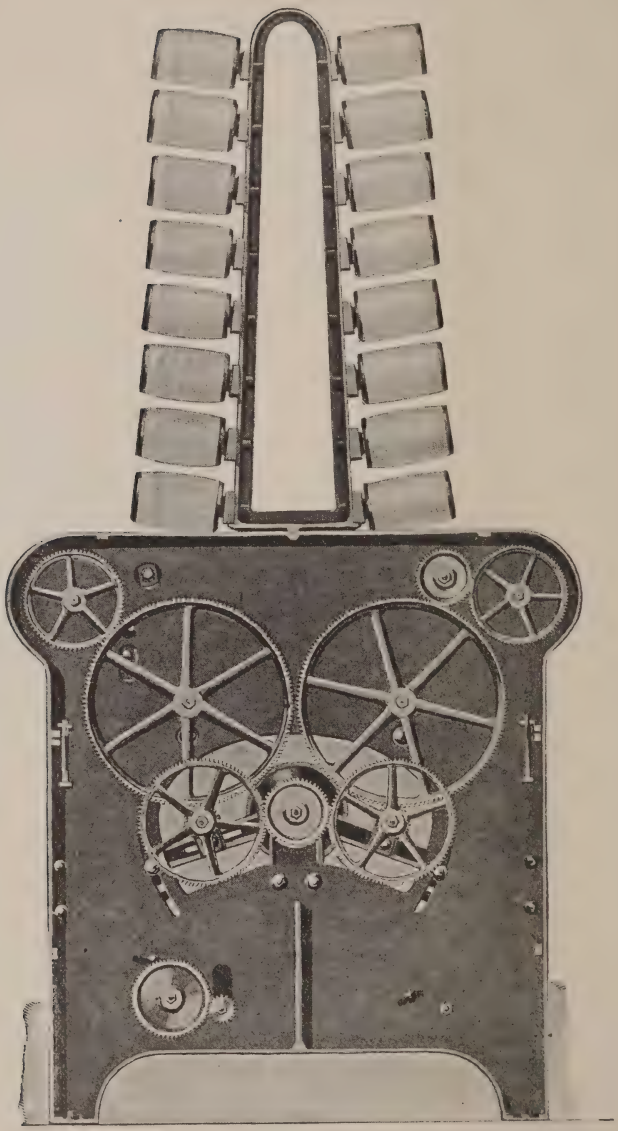




BRAKES.

Our Spindle brake is another neat idea, which we control exclusively, having purchased the American right from the English owners. With large heavy spindles, it is essential that the operative have an aid to keep the spindle from turning while piecing up. This brake is a simple casting, with knee plate A, extension to rest on rail, B, and a leather friction pad, C, which applies brake pressure and also overhangs the whorl, D, thus serving as a spindle retainer also.

By simply tilting the casting the spindle can be removed or raised. Nothing simpler could possibly be devised.



GEARED END OF TWISTER WITH COVER REMOVED.

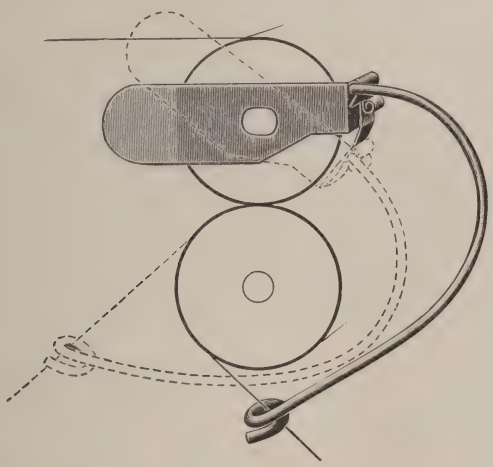
GEARING.

We believe our gearing is simpler and more convenient for change than on any other machine that we know of.

The twist gear is directly on the end of the cylinder shaft. With our arrangement, the range is greater with less changes, and we get less noise. Every gear is machine cut. The cut shows a double gear drive which is not usually necessary.

Our Traverse Motion is also arranged for change gears and proper attention to their use will result in a large gain in the amount of yarn wound on the bobbins between doffs. Where the traverse is run at the same speed for different threads, there is certain to be a loss under conditions, for which the speed is not properly adapted, causing the thread to wind under, or pile on the bobbin in one case, or waste space by winding with too great volume.

We have a simple lever clutch to throw the worm operating the traverse out of gear so that the ring rail may be lowered at any time. It is not therefore necessary to stop the frames at closing time with the rails at their low point of traverse.

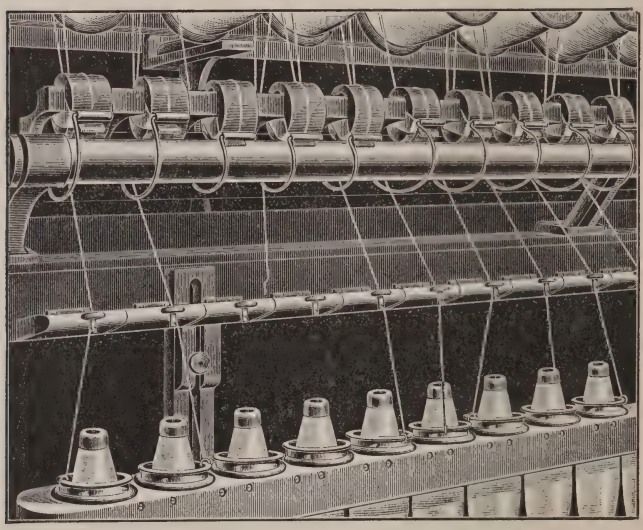


THE T. H. SMITH TWISTER STOP-MOTION.

We take pleasure in announcing that after years of experiment, invention has finally produced a successful twister stop motion for dry twisting of sufficient simplicity to meet the approval of the most conservative mill management.

The device is shown in the cuts and consists in a simple bent wire attached to a sheet metal holder, having a hole or bearing to encircle the top-roll pivot, also a flexible

metallic (German silver) tongue to engage the top roll and stop the same when necessary. The wire end drops when not held up by the perfect thread allowing the tongue to feed in between the rolls. In operation this device practically stops all waste on twisters. It is simple, cheap and effective, and can be applied when the frame is running. Its use will prevent roller-laps, enables the help to tend more spindles, and allows the speed to be increased. A recent improvement consists in extending the rear portion of the signal so that it will stick up prominently and attract the eye of the operative when an end is broken. This was invented by Mr. David Clark of the Ada Mfg. Co.



1 2 3 4 5 6 7 8 9

Referring to the illustration, spindles Nos. 1, 2, 5, 6, 7, 8 and 9 have unbroken threads.

No. 3 shows the operation with the end broken back in the creel.

No. 4 shows a spindle with the thread broken down in front.

No. 5 shows a spindle which had a band cut off while the frame was running. In the latter case, the stop-motion holds the end unbroken until a new band is put on.

A thousand pounds of 2-40 cotton yarn can be twisted with less than one ounce of waste.

The device is more valuable for worsted than cotton.

In addition to the advantages already mentioned, the following are also worthy of consideration:

Saving in waste at the twister is important, as such waste cannot be re-spun.

The device will operate when either thread of a two-ply yarn breaks.

Broken ends are held in place and do not lash around and break others.

Frame can be started up after doffing without stopping to piece up.

Using this attachment, a twister will run better and make less waste, using single-end spools from the common spooler, than from spools wound by the expensive double process on a stop-motion spooler.

In one mill, a twister of one hundred and eighty spindles with stop-motion applied on worsteds, saves ten ounces per week of waste per spindle worth seventy-five cents per pound.

The following quotation gives a good idea of the possible results on cotton:

"We have kept a close record of our hard waste on the enclosed blank and are therefore able to give you exact data instead of estimates.

Twister spindles on 8-3 ply 576, on 20-2 ply 3264. Total 3840.

	Lbs.
Average twister waste per week without stop motions,	*76*
" " " " " with " "	*42*
Average saving per week,	*34*

The following is our estimate of the amount saved by the stop motions.

Average value of yarn 16c, of white thread 4c, of twister sweeps, 1-2c.

34 lbs. white thread at 16c—4c.	*$4.08*
17 lbs. of sweeps at 16c—1-2c.	*2.64*
1c per side per day on 24 frames,	*2.88*
Amount saved per week,	*$9.60*
Saving for 51 weeks,	*$489.00*
36 per cent. on investment of	*$1340.00*

We estimate that the saving in twister sweeps is one-half as much as in twister thread.

On account of Mr. Clark's improvement we were able to give an operative more sides and pay 1c. less per side.

It is impossible to estimate the saving from claims. We know of one claim of $200 for doubling in our yarn, that was withdrawn as soon as we proved that there could not have been any doubling because we had stop-motions."

In placing an order for twisters, use the same grade of business sense that wins success in every line. Investigate thoroughly and have the best without regard to former custom. If we make superior machinery, we expect to sell it, and if there are better machines we trust we shall be the first to find it out.

Table of Twist Gears for Hopedale Machine Company's Twister.

This table gives the number of teeth required in cylinder gears with a given stud gear to produce a theoretical twist with 8-inch cylinder and 1/8-inch band. No allowance is made for contraction.

Diameter of whirl . . .	2½	2¼	1¾	1¼	1⅛	1	⅞
Teeth in stud gear . . .	36	32	36	38	32	28	26
Teeth in cylinder gear.	TWIST.						
18	10.95	13.61	15.33	19.80	25.86	32.85	39.79
19	10.37	12.90	14.52	18.77	24.50	31.12	37.54
20	9.85	12.25	13.79	17.82	23.28	29.56	35.81
21	9.38	11.67	13.14	16.97	22.17	28.15	34.11
22	8.95	11.14	12.54	16.20	21.16	26.87	32.55
23	8.57	10.65	11.99	15.50	20.24	25.70	31.14
24	8.21	10.21	11.49	14.85	19.40	24.63	29.84
25	7.88	9.80	11.03	14.25	18.62	23.65	28.65
26	7.58	9.42	10.61	13.70	17.90	22.74	27.55
27	7.30	9.07	10.22	13.19	17.24	21.90	26.53
28	7.04	8.75	9.85	12.71	16.63	21.12	25.58
29	6.79	8.45	9.52	12.29	16.05	20.39	24.70
30	6.57	8.17	9.20	11.88	15.52	19.70	23.87
31	6.36	7.90	8.90	11.50	15.02	19.06	23.10
32	6.16	7.66	8.62	11.14	14.55	18.47	22.38
33	5.97	7.42	8.36	10.80	14.11	17.91	21.70
34	5.80	7.21	8.11	10.48	13.69	17.38	21.06
35	5.63	7.00	7.88	10.18	13.30	16.89	20.46
36	5.47	6.81	7.66	9.90	12.93	16.42	19.89
37	5.33	6.62	7.45	9.63	12.58	15.98	19.36
38	5.19	6.45	7.26	9.38	12.25	15.56	18.85
39	5.06	6.28	7.08	9.14	11.94	15.16	18.36
40	4.93	6.13	6.90	8.91	11.64	14.78	17.90
41	4.81	5.98	6.73	8.69	11.35	14.42	17.47
42	4.69	5.83	6.57	8.48	11.08	14.07	17.05
43	4.58	5.70	6.42	8.29	10.83	13.75	16.66
44	4.48	5.57	6.27	8.10	10.58	13.44	16.28
45	4.38	5.44	6.13	7.94	10.35	13.14	15.92
46	4.29	5.33	6.00	7.75	10.12	12.86	15.57
47	4.20	5.21	5.87	7.58	9.90	12.58	15.24
48	4.11	5.10	5.75	7.42	9.70	12.32	14.92
49	4.02	5.00	5.63	7.28	9.50	12.07	14.62
50	3.94	4.90	5.52	7.13	9.31	11.82	14.32
51	3.87	4.80	5.41	6.98	9.13	11.59	14.04
52	3.79	4.71	5.31	6.85	8.95	11.37	13.77

This table is figured for a 1 1-2 inch bottom roll, with a 90 tooth gear on the front roll, and a 120 tooth Jack gear.

The ordinary ranges of twist required are given in the above table. If any twist not given is necessary, it can be obtained within a small fraction of a turn, by changing both stud and cylinder gears. All gears are interchangeable, and have same size nut requiring but one size of wrench to make any change.

SPECIFICATIONS OF TWISTERS,

ORDERED FROM THE DRAPER COMPANY, HOPEDALE, MASS.

Name..... Date..... .....19....

Place .....

Ship to..... .....Via. what route ....

How many Wet Twisters?.. .....

How many Dry Twisters?.. ....

How many Spindles in each?.. ....

Are Brakes required on Spindles?.....

What Pattern of Spindle? (Draper, Whitin, Sawyer, etc.).....
If matching a present lot, send sample bobbin and spindle to ensure duplication.

Single or double Boss Top Rolls? .....

Single or double Line Bottom Rolls? ....

What Gauge? .....

Kind of Ring? (Vertical or flat-top.) .....

Size of Ring?.....

Is Carter Oiling Device desired on Vertical Rings? (Extra charge for this.) .....

What length traverse?.....

Will you have Warp or Filling wind?.....

Will you have Single or Double-headed Bobbin?.. .....

What number yarn will you twist?..... .....

How many ply?.....

For how many turns twist per inch shall Twisters be geared?..
We furnish three twist gears and charge extra if more are ordered.

Will you twist from beams or spools?..... .....

How belted, from above or below? .....

Do you want T. H. Smith Stop-Motion? (Recommended especially for two-ply. Extra charge.) .....

Do you want Wire Board Lifters? .....

If you twist from spool, send sample that you twist from.....

Single or double cylinder?.....

Cylinders on new pattern Twisters, unless otherwise specified, are 8 inches diameter. .....

Pulleys run from 8 to 20 inches, rising by half inches, 2¼ to 4¼ inch faces; what size will you have? .....

Is a narrower width than our regular size twister required?.....

Shall machines be Crated, Shod, or taken down and Boxed?.....

Remarks. .....

.....

☞We recommend 12-inch or larger pulleys.

In sending Spools, please specify on same where from.

DIMENSION OF TWISTERS.

These are figured for 2¼ inch pulleys. If other width pulleys are ordered, add to these figures for length, twice the extra width of a pulley. Example—with 3 3-4 inch pulleys, add 3 inches.

Size of Ring	1¾ in.	2 in.	2¼ in.	2½ in.	3 in.	3½ in.	4 in.	4½ in.
Space between centres of spindles, or guage	2¾ in.	3 in.	3¼ in.	3½ in.	4 in.	4½ in.	5 in.	5½ in.
* Total width	3 ft. 3½ in.	3 ft. 3¾ in.	3 ft. 4 in.	3 ft. 4¼ in.	3 ft. 4¾ in.	3 ft. 5¼ in.	3 ft. 5¾ in.	3 ft. 6⅜ in.
Approximate weight per spindle in pounds	31	33	36	39	43	46	51	54

Number of Spindles.	LENGTH OF TWISTERS OVER ALL, IN FEET AND INCHES.							
240	29 6	32 0						
220	27 2½	29 6	31 9½					
200	24 11	27 0	29 1	31 2				
180	22 7½	24 6	26 4½	28 3	32 0			
160	20 4	22 0	23 8	25 4	28 8	32 0		
144	18 6	20 0	21 6	23 0	26 0	29 0	32 0	
140	18 0½	19 6	20 11½	22 5	25 4	28 3	31 2	
128	16 8	18 0	19 4	20 8	23 4	26 0	28 8	31 4
120	15 9	17 0	18 3	19 6	22 0	24 6	27 0	29 6
112	14 10	16 0	17 2	18 4	20 8	23 0	25 4	27 8
108	14 4½	15 6	16 7½	17 9	20 0	22 3	24 6	26 9
100	13 5½	14 6	15 6½	16 7	18 8	20 9	22 10	24 11
96	.....	14 0	15 0	16 0	18 0	20 0	22 0	24 0
90	.....	.....	14 2¼	15 1⅛	17 0	18 10½	20 9	22 7½
84	.....	.....	.....	14 3	16 0	17 9	19 6	21 3
80	.....	.....	.....	13 8	15 4	17 0	18 8	20 4
72	.....	.....	.....	.....	14 0	15 6	17 0	18 6
64	.....	.....	.....	.....	.....	14 0	15 4	16 8

To ascertain the length of Twister, with any number of spindles: Multiply one-half the number of spindles by the distance between centres of spindles, add 24, and divide by 12; the quotient and remainder will be the total length in feet and inches.

Diameter of driving pulleys 8 to 20 inches, with 2 1-4-inch face. Cylinders are 8 inches in diameter unless otherwise specified.

* Width of Twister on floor 3 feet, 2 inches; the ring rails project beyond other parts, making total width as given above for all sizes at ring rail. The width of head end on level with front roll is 3 feet, 7 3-4 inches. This is the regular width. We make others to order when specified.

PRODUCTION OF TWISTERS.

In preparing tables of production of our twisters, we have assumed the number of the yarn after twisting to be one-half for 2-ply, and one-fourth for 4-ply, of the number before twisting; the twist is indicated by the number at the head of table by which the square root of the twisted yarn is multiplied. (See twist tables 94-98.) The figures given cover the most common sizes of ring and numbers of yarn. What we consider to be a fair allowance for loss by all causes from the theoretical production has been made.

While tables published by other parties give higher figures, they often fail to appreciate the practical limits enforced by the ring and traveler. OUR TWISTERS WILL GIVE AS LARGE A PRODUCT AS ANY, but we do not care to make excessive claims which cannot be carried out by the average user. In accordance with modern practice we have made the following assumptions:

Traverse.—6 inches in all cases.

Bobbin head diameter.—Top $\frac{1}{4}$ inch less than ring diameter for rings larger than $2\frac{1}{2}$ inches, and $\frac{1}{2}$ inch less than ring diameter for rings $2\frac{1}{2}$ and less. Bottom head $\frac{1}{4}$ inch less than diameter of ring in all cases.

Gauge of frame.—1 inch more than diameter of ring in all cases.

Roll speed is figured in exact proportion to the spindle speed and twist, on the assumed basis that contraction in length due to twist is offset by the extra turns of the spindle that are necessary to wind the yarn on the bobbin.

For example: To find the roll speed, divide the spindle speed by the circumference of the bottom roll and then divide the result by the twist per inch.

As bottom roll is $1\frac{1}{2}$ inches in dia. the circumference $=3.1416\times1.5=4.7124$.

Spindle speed for No. 6 yarn is $4500\div4.7124=954.92$.

If twist with multiplier 4 is used consult the twist table which gives 6.93 for the square root of 6 multiplied by 4.

$954.92\div6.93=137.8$ as number of revolutions. The tables give 138 as the nearest equivalent.

Production is figured directly from the delivery of the front roll.

Taking the example of No. 6 yarn as above, multiply the circumference—4.7124 inches by 138 turns per minute=650.3112 inches of delivery per minute. $650.3112\times600=390186.72$ inches of delivery per day. As there are 30,240 inches in a hank, $390186.72\div30.240=12.9$ hanks per day $\div3$ (The number of 6 two-ply)$=4.3$ pounds per day, the theoretical production of continuous running.

PER CENT. OF ALLOWANCE FOR STOPS IN TWISTING.

Number of Yarn.	2 Ply.	3 Ply.	4 Ply.	6 Ply.
6	14	15	17	20
7	14	15	16	18
8	13	14	15	17
9	13	14	15	16
10	12	13	14	15
12	12	13	14	15
14	11	12	13	14
16	11	12	13	14
18	10	11	12	13
20	10	11	12	13
22	9	10	11	12
24	9	10	11	12
26	9	9	10	11
28	8	9	10	11
30	8	9	9	10
32	8	8	9	10
34	7	8	9	9
36	7	8	8	9
38	7	7	8	9
40	6	7	8	8
42	6	7	7	8
44	6	6	7	8
46	5	6	7	7
48	5	6	6	7
50	5	5	6	7
60	5	5	6	6
70	4	5	5	6
80	4	5	5	6

In order to make a proper allowance for loss of time due to doffing, etc., it is necessary to find out what results are actually obtained and work out a systematic table. The above basis has been assumed for our own figures. The percentage varies with the ply and number of yarn, but not with the twist.

Taking the same problem as before, with the theoretical product of 4.3 pounds, the table would recommend a percentage reduction of 14 per cent. $4.3 \times .14 = .602$

$4.3 - .602 = 3.69$—Answer

Same as given in the Production tables.

TABLE SHOWING NUMBER OF POUNDS OF TWISTED YARN PRODUCED IN 10 HOURS—2 PLY.
FRONT ROLL 1½ IN. IN DIAMETER IN ALL CASES.

No. of Yarn to be Twisted.	Rev. of Spindle per Minute.	Dia. of Ring in Inches.	Dia. of Bobbin Barrel.	Weight of Yarn in Pounds on Bobbin.	Multiplier 3.		Multiplier 4.		Multiplier 5.		Multiplier 6.	
					Rev. per Minute of Roll.	Pounds per Spindle.	Rev. per Minute of Roll.	Pounds per Spindle.	Rev. per Minute of Roll.	Pounds per Spindle.	Rev. per Minute of Roll.	Pounds per Spindle.
6	4500	3	1¼	.42	184	4.92	138	3.69	110	2.94	92	2.47
7	4500				170	3.90	127	2.67	102	2.34	85	1.95
8	4500				159	3.22	119	2.41	95	1.93	79	1.60
9	4500				150	2.70	112	2.01	90	1.63	75	1.36
10	4500				142	2.33	107	1.76	85	1.40	71	1.17
12	5300	2½	1	.331	153	2.10	115	1.57	91	1.25	76	1.04
14	5300				141	1.67	106	1.25	85	1.01	70	.83
16	5300				132	1.37	99	1.02	79	.82	66	.68
18	5300				125	1.17	93	.87	75	.70	62	.58
20	5300				118	.99	89	.75	72	.61	59	.50
22	6000	2¼	1	.247	128	.99	96	.74	76	.59	64	.50
24	6000				122	.86	92	.65	73	.52	61	.43
26	6000				118	.77	88	.58	70	.46	58	.39
28	6000				113	.69	85	.52	68	.42	56	.34
30	6000				109	.62	82	.47	65	.37	54	.31
32	6000				106	.57	79	.42	63	.34	53	.28
34	6000				103	.52	76	.39	61	.31	51	.26
36	7000	2	⅞	.180	116	.56	87	.42	70	.34	58	.28
38	7000				114	.52	85	.39	68	.31	56	.26
40	7000				111	.49	83	.36	66	.29	55	.24
42	7000				108	.45	81	.34	64	.27	54	.23
44	7000				106	.42	79	.31	62	.25	52	.21
46	7000				104	.40	77	.30	61	.23	51	.19
48	7000				101	.37	75	.28	60	.22	50	.19
50	7500	1¾	⅞	.117	106	.38	79	.28	63	.22	53	.19
60	7500				97	.29	72	.21	58	.17	48	.14
70	8000				95	.24	71	.18	57	.15	47	.12
80	8000				89	.20	67	.15	53	.12	44	.10

TABLE SHOWING NUMBER OF POUNDS OF TWISTED YARN PRODUCED IN 10 HOURS—3 PLY.
FRONT ROLL 1½ IN. IN DIAMETER IN ALL CASES.

No. of Yarn to be Twisted.	Rev. of Spindle per Minute.	Dia. of Ring in Inches.	Dia. of Bobbin Barrel.	Weight of Yarn in Pounds on Bobbin.	Multiplier 3.		Multiplier 4.		Multiplier 5.		Multiplier 6.	
					Rev. per Minute of Roll.	Pounds per Spindle.	Rev. per Minute of Roll.	Pounds per Spindle.	Rev. per Minute of Roll.	Pounds per Spindle.	Rev. per Minute of Roll.	Pounds per Spindle.
6	3700	3½	1¼	.645	185	7.35	139	5.52	111	4.40	93	3.69
7	3700				172	5.87	129	4.40	103	3.51	86	2.93
8	3700				161	4.87	120	3.62	96	2.86	80	2.41
9	3700				151	4.05	113	3.03	90	2.41	76	2.04
10	3700				144	3.51	108	2.64	86	2.10	71	1.73
12	4500	3	1¼	.420	159	3.23	119	2.42	96	1.95	80	1.63
14	4500				148	2.61	110	1.94	89	1.57	74	1.31
16	4500				138	2.13	103	1.59	83	1.28	69	1.06
18	4500				130	1.80	97	1.34	78	1.08	65	.90
20	4500				124	1.55	92	1.15	74	.91	62	.77
22	5300	2½	1	.331	139	1.59	104	1.19	83	.95	69	.78
24	5300				133	1.39	100	1.05	80	.84	66	.69
26	5300				128	1.25	96	.94	76	.75	64	.63
28	5300				123	1.12	92	.84	74	.67	62	.56
30	5300				119	1.01	89	.76	71	.60	59	.50
32	5300				115	.92	86	.69	69	.55	57	.45
34	5300				112	.85	83	.63	67	.51	56	.42
36	6000	2¼	1	.247	123	.88	92	.66	74	.53	61	.44
38	6000				120	.82	89	.61	72	.49	60	.41
40	6000				117	.76	87	.57	70	.46	58	.37
42	6000				114	.71	85	.53	68	.42	57	.35
44	6000				111	.67	83	.50	67	.40	56	.33
46	7000	2	⅞	.180	127	.73	95	.54	76	.44	63	.36
48	7000				124	.68	93	.51	74	.41	62	.34
50	7000				122	.65	91	.49	73	.39	61	.32
60	7000				111	.49	83	.37	66	.29	55	.24
70	8000	1¾	⅞	.117	117	.45	88	.33	71	.27	59	.22
80	8000				110	.37	82	.27	66	.22	55	.18

TAALE SHOWING NUMBER OF POUNDS OF TWISTED YARN PRODUCED IN 10 HOURS—4 PLY.
FRONT ROLL 1½ IN. IN DIAMETER.

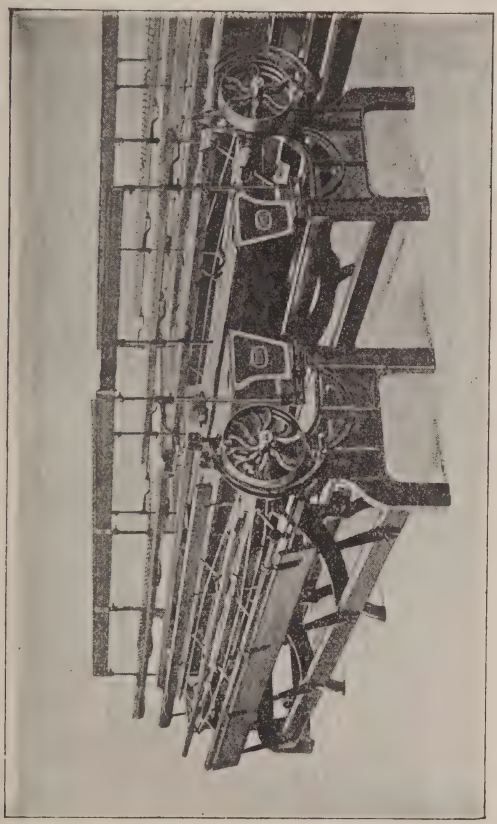
No. of Yarn to be Twisted.	Rev. of Spindle per Minute.	Dia. of Ring in Inches.	Dia. of Bobbin Barrel.	Weight of Yarn in Pounds on Bobbin.	Multiplier 3.		Multiplier 4.		Multiplier 5.		Multiplier 6.	
					Rev. per Minute of Roll.	Pounds per Spindle.	Rev. per Minute of Roll	Pounds per Spindle.	Rev. per Minute of Roll.	Pounds per Spindle.	Rev. per Minute of Roll.	Pounds per Spindle.
6	3000	4	1½	.855	174	9.00	130	6.72	104	5.38	87	4.50
7	3000				161	7.22	121	5.43	97	4.35	80	3.59
8	3000				150	5.96	113	4.49	90	3.58	75	2.98
9	3000				142	5.02	106	3.74	85	3.00	71	2.51
10	3000				135	4.34	101	3.25	81	2.61	67	2.16
12	3700	3½	1¼	.645	152	4.07	113	3.03	91	2.44	76	2.04
14	3700				140	3.25	105	2.47	84	1.95	70	1.63
16	3700				131	2.66	98	1.99	79	1.61	65	1.32
18	3700				124	2.27	93	1.70	74	1.35	62	1.13
20	3700				117	1.93	88	1.45	70	1.15	58	.95
22	4500	3	1¼	.420	136	2.06	102	1.54	81	1.22	68	1.03
24	4500				130	1.80	97	1.34	78	1.08	65	.90
26	4500				125	1.60	94	1.21	75	.96	62	.79
28	4500				120	1.44	91	1.09	72	.87	60	.72
30	4500				116	1.32	88	.99	70	.79	58	.66
32	4500				112	1.19	85	.90	68	.72	56	.59
34	4500				109	1.09	82	.82	66	.66	55	.55
36	5300	2½	1	.331	125	1.20	94	.90	75	.72	63	.60
38	5300				122	1.10	91	.82	73	.66	61	.55
40	5300				119	1.02	89	.77	71	.61	59	.51
42	5300				116	.96	87	.71	69	.57	58	.48
44	5300				113	.89	85	.67	68	.54	57	.45
46	7000	2	⅞	.180	146	1.12	110	.83	88	.67	73	.55
48	7000				143	1.04	107	.78	86	.63	72	.53
50	7000				140	1.00	105	.74	83	.58	70	.49
60	7000				128	.76	96	.56	77	.45	64	.37
70	8000	1¾	⅞	.117	135	.69	101	.51	81	.41	68	.34
80	8000				126	.56	95	.42	76	.34	64	.28

TABLE SHOWING NUMBER OF POUNDS OF TWISTED YARN PRODUCED IN 10 HOURS—6 PLY.
FRONT ROLL 1½ IN. IN DIAMETER IN ALL CASES.

No. of Yarn to be Twisted.	Rev. of Spindle per Minute.	Dia. of Ring in Inches.	Dia. of Bobbin Barrel.	Weight of Yarn in Pounds on Bobbin.	Multiplier 3.		Multiplier 4.		Multiplier 5.		Multiplier 6.	
					Rev. per Minute of Roll.	Pounds per Spindle.	Rev. per Minute of Roll.	Pounds per Spindle.	Rev. per Minute of Roll.	Pounds per Spindle.	Rev. per Minute of Roll.	Pounds per Spindle.
6	2500	4½	1½	1.160	177	13.24	133	9.95	106	7.93	89	6.66
7	2500				164	10.84	123	8.13	98	6.48	82	5.42
8	2500				153	8.93	115	6.71	92	5.37	77	4.49
9	2500				145	7.59	109	5.71	87	4.56	72	3.77
10	2500				137	6.56	103	4.93	82	3.93	69	3.30
12	3000	4	1½	.855	150	5.96	113	4.49	90	3.58	75	2.98
14	3000				139	4.80	105	3.62	83	2.86	69	2.38
16	3000				130	3.93	98	2.96	78	2.36	65	1.97
18	3000				123	3.34	92	2.50	74	2.01	61	1.65
20	3000				116	2.83	87	2.12	70	1.71	58	1.42
22	3700	3½	1¼	.645	137	3.08	103	2.32	82	1.84	68	1.53
24	3700				131	2.70	98	2.02	79	1.63	65	1.34
26	3700				126	2.42	95	1.83	76	1.46	63	1.21
28	3700				121	2.16	91	1.63	73	1.30	61	1.09
30	3700				117	1.97	88	1.48	70	1.18	59	.99
32	3700				114	1.79	85	1.34	68	1.07	57	.90
34	3700				110	1.65	83	1.25	66	.99	55	.83
36	4500	3	1¼	.420	130	1.84	98	1.39	78	1.11	65	.92
38	4500				127	1.71	95	1.28	76	1.02	63	.87
40	4500				124	1.60	91	1.18	74	.96	62	.80
42	4500				121	1.49	90	1.11	72	.88	60	.73
44	4500				118	1.39	88	1.03	70	.82	59	.69
46	5300	2½	1	.331	136	1.54	102	1.15	81	.92	68	.77
48	5300				133	1.45	100	1.09	80	.87	66	.72
50	5300				130	1.36	98	1.02	78	.81	65	.68
60	5300				119	1.05	89	.78	71	.62	59	.52
70	6500	2	⅞	.180	135	1.02	101	.76	81	.61	67	.50
80	6500				126	.84	95	.62	76	.50	63	.42

REGARDING REELS.

In passing through our setting-up shop recently, we noticed a number of reels that were ready for shipment, and it seemed to us that if our customers could only note the merits of these machines, they would no longer be content with inferior substitutes. We therefore show a photographic reproduction of



this same lot in which the front and rear can alike be studied. We do not build reels for the profit there is in them. We have no patented features to attract by novelty. We simply build a satisfactory machine for the class of customer that will not spoil the harmony of his mill equipment by using the old-style cheap construction.

Our reel is constructed from entirely new designs, and is superior in most important points to all others, viz:—

The relative position of the different parts renders it much easier to operate than any other reel built.

The traverse motion is geared, therefore positive, making it impossible to wind other than a well-bound skein; consequently, the process of spooling, or other succeeding operation can be more rapid and less wasteful.

The bearing on driven end is set in ball and socket joint, so that it cannot be strained in lifting swift for removing yarn. The bearing on opposite end is entirely protected, preventing any oiling of skeins.

The releasing arms and traverse are furnished with metal bearings, fitted with metal boxes.

The shaft is of wood, insuring lightness, and for the purpose superior to any other material.

The bobbin box has waste box at each end and is protected from any drip from spindles.

We make them fitted with front spindles to fit cops, spinning or twister bobbins, each spindle removable independent of others. Spindle bearings have hinged protecting board, preventing dirt and flyings from lodging.

A gong is attached to strike at the completion of each hank of 840 yards, or when any other length desired has been reeled. We recommend maximum length of reel not to exceed 65 spindles.

For reasons above detailed, we claim a larger production in better condition, in a given time, with less waste.

SPECIFICATION FOR REELS.

Number of reels with driving pulleys on right hand end .....
Number of reels with driving pulleys on the left hand end .....
Number of spindles in each reel .....
Space between spindles .....
Size of skein desired (54, 60, 72, or 90 inch) .....
Reel to be belted from (above or below) .....
Gong to strike at each (hank or——yards) .....
Yarn to be reeled from (spool, bobbin, or cop.) Send sample full of yarn .....
Reels to be shipped (on shoes, in crates, or taken down and boxed) .....
Ship via .....
Remarks .....

Blank specification will be send on application.

DIMENSIONS OF YARN REELS.

Size of ring	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	2	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/2	3 3/4	4	4 1/4	4 1/2
Outside diameter of bobbin or cop	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	2	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/2	3 3/4	4	4 1/4
Space between centres of spindles	2	2 1/8	2 1/4	2 3/8	2 1/2	2 5/8	2 3/4	3	3 1/4	3 1/2	3 3/4	4	4 1/4	4 1/2	4 3/4	5

Number of spindles.	LENGTH OF REELS OVER ALL, IN FEET AND INCHES.																											
25	.....		.....		.....		.....		.....		.....		8	5	8	11	9	5	9	11	10	5	10	11	11	5	11	11	12	5
30	.....		.....		.....		8	1 7/8	8	5 1/2	8	9 1/8	9	0 3/4	9	8	10	3 1/4	10	10 1/2	11	5 3/4	12	1	12	8 1/2	13	3 1/2	13	10 1/2	14	6
35	.....		8	5 1/4	8	9 1/2	9	1 3/4	9	6	9	10 1/4	10	2 1/2	10	11	11	7 1/2	12	4	13	0 1/2	13	9	14	5 1/2	15	2				
40	8	11	9	3 7/8	9	8 3/4	10	1 5/8	10	6 1/2	10	11 3/8	11	4 1/4	12	2	12	11 3/4	13	9 1/2	14	7 1/4	15	5								
45	9	9	10	2 1/2	10	8	11	1 1/2	11	7	12	0 1/2	12	6	13	5	14	4	15	3												
50	10	7	11	1 1/8	11	7 1/4	12	1 3/8	12	7 1/2	13	1 5/8	13	7 3/4	14	8	15	8 1/4														
55	11	5	11	11 3/4	12	6 1/2	13	1 1/4	13	8	14	2 3/4	14	9 1/2																		
60	12	3	12	10 3/8	13	5 3/4	14	1 1/8	14	8 1/2	15	3 7/8																				
65	13	1	13	9 3/4	14	5	15	1																								
70	13	11	14	7 5/8																												
75	14	9																														

WIDTH OF REELS, IN FEET AND INCHES.

Size of skein	54″	60″	72″	90″
Extreme width of reel	3 0	3 2	3 6	4 0

We recommend maximum length of reel not to exceed 15 ft. 6 in. Diameter of driving pulleys, 12 in., with 1 3/4 in. face.

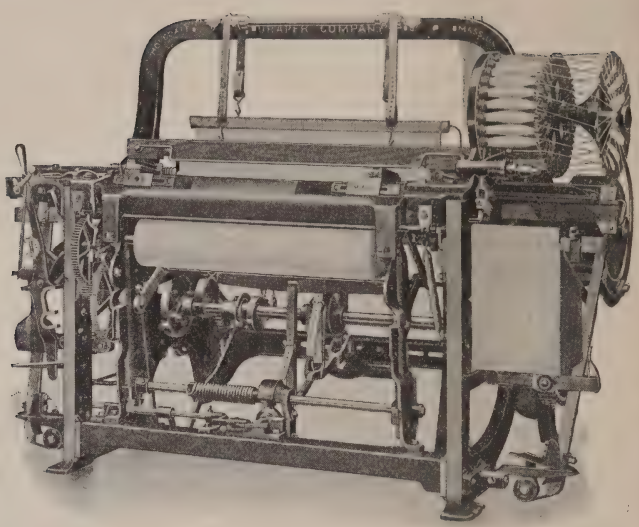
REEL PRODUCTION TABLES.

It is practically impossible to give any definite figures of reel production that can apply to the widely varying conditions. We therefore simply give a table of the theoretical maximum product if running were continuous, to furnish a basis from which a proper percentage reduction may be made. Reels are stopped anywhere from fifty to eighty per cent. of their possible running time in actual practice.

This table is for SINGLE YARN, and gives ten hours continuous product in pounds per spindle for the varying sizes. For yarns numbering from 1 to 9 inclusive, take the products for 10-90, etc., and multiply by 10. For instance, the product of a 54 inch reel at 120 revolutions on No. 5 yarns would be that of No. 50 yarn (2.57) multiplied by 10=25.7 pounds.

Reel Production Tables—Theoretical Continuous Result in Pounds per Spindle per Day.

No. Yarn.	54 Inch Reel.				60 Inch Reel.				72 Inch Reel.				90 Inch Reel			
	Revolutions per Minute.															
	120	130	140	150	120	130	140	150	110	120	130	140	100	110	120	130
10	12.85	13.92	15.00	16.07	14.28	15.47	16.66	17.85	15.71	17.14	18.57	20.00	17.85	19.64	21.42	23.21
11	11.68	12.65	13.63	14.60	12.98	14.06	15.14	16.22	14.28	15.58	16.88	18.18	16.22	17.85	19.47	21.10
12	10.70	11.60	12.50	13.39	11.90	12.89	13.88	14.87	13.09	14.28	15.47	16.66	14.87	16.36	17.85	19.31
13	9.89	10.70	11.53	12.36	10.98	11.90	12.81	13.73	12.08	13.18	14.28	15.38	13.73	15.10	16.47	17.85
14	9.17	9.94	10.71	11.47	10.20	11.05	11.90	12.75	11.22	12.24	13.26	14.28	12.75	14.02	15.30	16.57
15	8.57	9.28	10.00	10.71	9.50	10.31	11.10	11.90	10.47	11.42	12.38	13.33	11.90	13.09	14.28	15.47
16	8.03	8.70	9.38	10.04	8.92	9.66	10.41	11.15	9.81	10.71	11.60	12.50	11.15	12.27	13.38	14.50
17	7.56	8.19	8.83	9.45	8.40	9.10	9.80	10.50	9.24	10.08	10.92	11.76	10.50	11.55	12.60	13.65
18	7.14	7.74	8.34	8.93	7.93	8.59	9.25	9.91	8.72	9.52	10.31	11.11	9.91	10.91	11.90	12.89
19	6.76	7.33	7.90	8.46	7.52	8.14	8.77	9.40	8.27	9.02	9.77	10.52	9.40	10.33	11.27	12.21
20	6.42	6.96	7.50	8.04	7.14	7.74	8.33	8.93	7.86	8.57	9.28	10.00	8.93	9.82	10.71	11.60
21	6.12	6.63	7.15	7.65	6.80	7.37	7.94	8.50	7.49	8.16	8.84	9.52	8.50	9.35	10.20	11.05
22	5.84	6.33	6.82	7.30	6.49	7.03	7.57	8.12	7.15	7.80	8.44	9.10	8.12	8.93	9.74	10.55
23	5.59	6.05	6.53	6.99	6.21	6.73	7.25	7.77	6.83	7.45	8.07	8.70	7.77	8.55	9.32	10.09
24	5.35	5.80	6.25	6.70	5.95	6.45	6.94	7.43	6.55	7.15	7.74	8.33	7.43	8.19	8.92	9.67
25	5.14	5.57	6.00	6.43	5.71	6.19	6.67	7.14	6.28	6.86	7.43	8.00	7.14	7.86	8.57	9.29
26	4.94	5.36	5.77	6.18	5.49	5.95	6.40	6.87	6.04	6.60	7.15	7.70	6.87	7.55	8.24	8.93
27	4.76	5.16	5.55	5.95	5.29	5.73	6.17	6.61	5.82	6.35	6.88	7.41	6.61	7.27	7.93	8.60
28	4.59	4.97	5.36	5.74	5.10	5.53	5.95	6.38	5.61	6.13	6.63	7.15	6.38	7.02	7.65	8.29
29	4.43	4.80	5.17	5.54	4.92	5.33	5.75	6.15	5.42	5.91	6.41	6.90	6.15	6.78	7.39	8.00
30	4.28	4.64	5.00	5.35	4.76	5.15	5.55	5.95	5.24	5.72	6.19	6.67	5.95	6.55	7.13	7.74
40	3.21	3.48	3.74	4.01	3.57	3.87	4.16	4.47	3.93	4.29	4.64	5.00	4.47	4.91	5.35	5.80
50	2.57	2.78	3.00	3.21	2.86	3.10	3.33	3.57	3.14	3.43	3.71	4.00	3.57	3.93	4.28	4.64
60	2.14	2.32	2.50	2.68	2.39	2.58	2.78	2.98	2.62	2.86	3.10	3.34	2.98	3.28	3.57	3.87
70	1.83	1.99	2.14	2.29	2.04	2.21	2.38	2.55	2.24	2.45	2.65	2.86	2.55	2.81	3.06	3.32
80	1.60	1.74	1.87	2.01	1.78	1.93	2.08	2.23	1.96	2.14	2.32	2.50	2.23	2.46	2.68	2.90
90	1.42	1.55	1.67	1.78	1.59	1.72	1.85	1.98	1.74	1.90	2.06	2.22	1.98	2.18	2.38	2.58
100	1.28	1.39	1.50	1.60	1.42	1.54	1.66	1.78	1.57	1.71	1.85	2.00	1.78	1.96	2.14	2.32

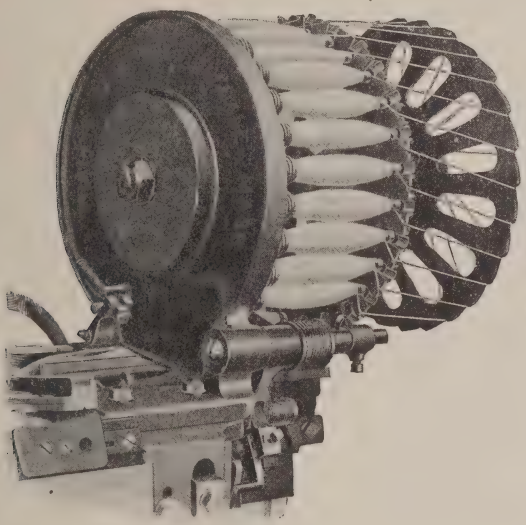


THE NORTHROP LOOM.

It is not our intention to make this article complete and comprehensive, for we issue a separate loom pamphlet for that purpose, which we will be glad to send to any interested party. We therefore simply refer briefly to a few of our more prominent features, especially those introduced since the publication of our former loom pamphlet, one year ago. The success of this machine is no longer a matter of theory or speculation, for we could stop where we are and still consider the record most satisfactory. We shipped over 16,000 looms in the year of 1900 alone, and our total sales to date, including old looms changed over, runs over the 70,000 mark. They are built in four foreign countries, to date, with preparation being made for a still wider outside exploitation. That sure sign of merit, competition, has also added its approval, but the strength of our patent protection has prevented any serious encroachment on our territory: in fact, at the time of writing, there is no single section of filling changing looms not built by ourselves, or our licensees, which has given the satisfaction necessary to secure either a payment for the present looms sold, or an order for a larger number. The visionary sales made on the basis of an approved trial lot, awaken no

apprehension on our part, as we deny the possibility of successful attack by incompetent devices, and believe our education in this special line is broad enough by which to pass judgment on mechanical sins. We ourselves certainly dared predict, but not until the actual proof of eighty looms continuously run for months, by five weavers, had demonstrated a certain basis of fact. We are willing to submit all the matter printed over our name within the past six years to criticism, believing that our under-statements, in general, will greatly over balance any over-statements, in detail.

Dealing with the more important parts of the loom in turn, we first present the Filling Changer, or Hopper, or Battery, or Magazine, as it is variously termed. This attachment fur-



nishes the great element of labor saving, by which weavers are enabled to tend twice, thrice, and even four times, their former number of looms. As recently improved, the hopper is designed to hold twenty-five extra bobbins, or cops, of filling, in place of fifteen, as formerly. This undoubtedly increases the capacity of the operative still further, for we proved by an absolute test on our old hopper, that a reduction from fifteen to a smaller number, placed an absolute restriction on the weaver's capacity; and the converse of the proposition is a natural sequence. This is one of the many reasons why a shuttle changing loom can never compete with a filling changer,—the more serious reason, however, being because

NO. 16
SHUTTLE.

BOBBIN
for
Northrop
Loom.

COP
SKEWER
for
Northrop
Loom.

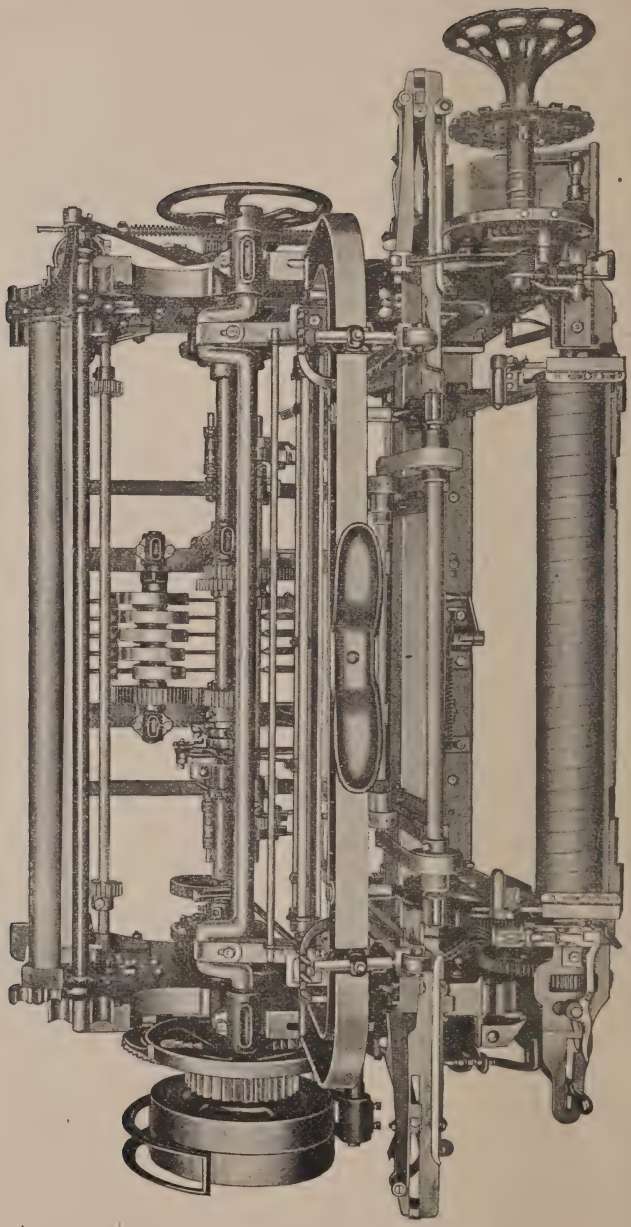
Both bobbins and cop-skewers are made in different lengths and patterns to suit the conditions required. Both are held in place in the shuttle by the rings on the base which engage grooves in the shuttle spring.

with a shuttle changer the weaver absolutely has to go through nearly as much work as with the common loom, the only saving being in the possible number of steps taken in going from loom to loom. The new hopper is also much simplified in the detail of its mechanism, so that fewer and simpler parts perform the same work, and with even greater accuracy than before. The new hopper has also removed some of the few troubles formerly found with the use of cops on our loom; although the Cop loom can never compete on an absolute equality with the Bobbin loom, as the skewering must necessarily always require some extra labor.

The devices which co-operate with the Filling Changer, such as the shuttle, the bobbins, the cop skewers, the shuttle position detector, etc., have all been modified recently, with good results. Our shuttles are designed so as to be less liable to split or be damaged than formerly, our bobbins are now made with large butts, so that they wear better, and change less in reaming, and the position detector is greatly reduced in parts, and operates in a more positive manner than formerly.

We have found it necessary to devise various forms of Warp-Stop Motion, for various goods, and are not forced by circumstances to depend on any one single type. Our now familiar steel harness style is absolutely superior to any other class for two-harness weaving on ordinary goods. It will not do for very close sley, very wide goods, or goods woven with a heavy strain on the warp. Our drop-wire system, in which one detector operates for more than one thread, has been our most popular form for miscellaneous goods, up to a recent period. We also have single-thread stop motions, so called, which can be used with any number of harnesses.

Our devices for matching the pick comprise various systems. For four and five harness weaving, we sometimes advise the use of a little trip on the fork controller, which delays the action of the filling-changer for two extra picks, thus weaving the new yarn supply into the proper shed, or at least the one adjacent to it. The only sure method of making absolutely perfect cloth, by any system, is to supply new filling before the old filling is absolutely exhausted. We accomplish this by use of what we call a "*Feeler*" device, which positively engages the filling in the shuttle while weaving, to determine when it has lost volume sufficiently to warrant the operation of the filling-changer to insert a new supply. The problem of the waste yarn left on the expelled bobbin is met by removal as waste, or by piecing up from these bobbins on the spinning frame, in which case there need be no loss whatever. We believe a systematic and persistent trial of this idea



TOP VIEW OF A NORTHROP LOOM.

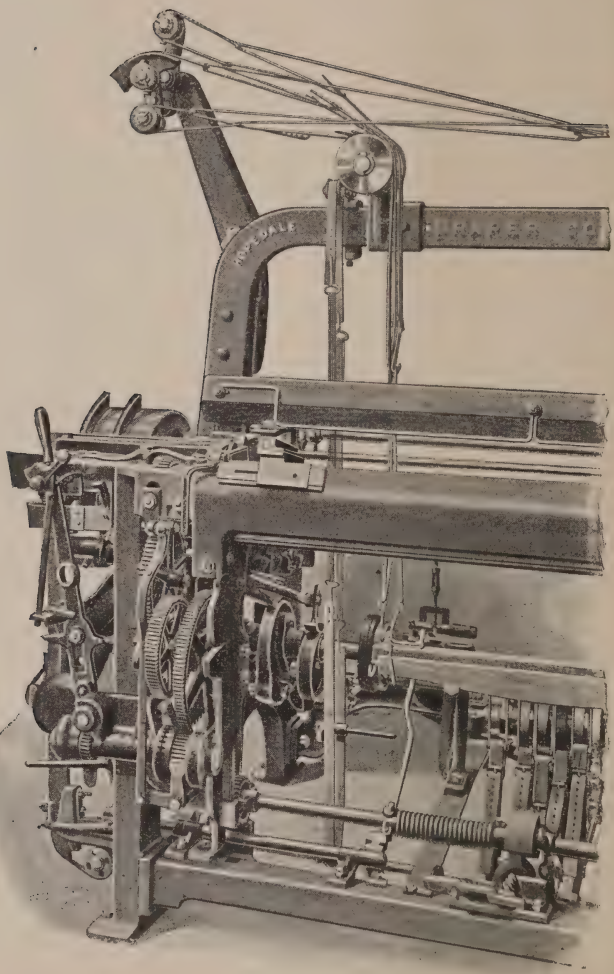
will give results of great benefit to manufacturers. Our loom produces such perfect cloth as ordinarily equipped, that there has been less trial of this idea that we should have expected. Co-operating with any device of this kind, is an extra thread-cutter to sever the yarn end of the expelled bobbin. The yarn end from the new bobbin to the hopper is cut by a cutter on the temple itself, but the feeler device introduces the necessity for an additional cutting operation.

Coming to the general loom details, we found when entering the field as loom builders, that there was decided room for improvement, and we have practically revolutionized the art in several important directions; for instance, we were the first to recognize the apparent absurdity of building these machines in rights and lefts, when it was only necessary to devise a simple belt shipping attachment in order to enable the pulleys to be set at either side of the loom. The advantages which accrue from this change are almost too manifest to need explanation. The weaver does not have to learn double hand operations, the fixer has but one style of mechanism to keep in order, and the repair department has less parts to keep in stock.

Another marked change is our universal adoption of the High-Roll Take-Up idea, in which the cloth passes directly from the temples to the rough-surfaced roller, thereby preventing shrinkage, wrinkling, and undesirable elasticity in the cloth itself. This system also allows the weaving of long rolls of cloth at a time, makes the cloth much more uniform in width, reduces warp breakage, and makes more even cloth. We have recently adopted an improvement, in the use of an additional rod so placed that the cloth is held against a larger portion of the circumference of the take-up roller. This not only insures a more positive grasp, but enables a roll of cloth to be taken off the loom without any chance of slipping back.

Our Take-Up Rolls are made of iron, which, while expensive for us, is of great importance to the mill, as it prevents all liability of shrink or swell, which might vary the picks in the cloth.

On our shedding mechanism we use the ordinary straps and jacks for two-harness work. For 3, 4, 5, and 6-harness, we recommend our Patent Lacey Top-Rig, which is by all means the most perfect and simple arrangement for controlling multiple harness weaving, giving sheds of uniform depth, and operating without the usual excessive wear. It is always in place to hang a warp, thereby simplifying the fixer's work, and saving in time. For looms running more than six harnesses, we use the Crompton & Knowles Dobby, or equip with side cams.



DETAIL OF LACEY TOP RIG.

Cut also shows our worm gear take-up with a let-back modification.

We have many minor points of construction which are novel, and of great advantage, such as our Indicator, which is a simple finger, operated near the shipper handle, which, by its position allows the weaver to know instantly, when the loom is stopped, just what cause has produced the result: for instance, the loom stops if a warp thread is broken, if the filling detector has repeatedly missed in threading the shuttle, and if the protector operates because the shuttle is not properly boxed. A glance at the Indicator suffices to let the weaver know where to look immediately for the cause.

While we always had a comparatively efficient Brake mechanism, it was discovered that slight faults in assembling could largely counteract its service. By the simple means of an adjusting screw, our brake can now be instantly set so that the cracks, or slight thin places in the cloth usually arising from any cause that stopped the loom, may be absolutely obviated.

Another small detail is our Eccentric Binder Bushing, and Raw Hide Bearing, enabling better setting of the shuttle box, and greatly reducing wear.

POINTS OF IMPORTANCE.

We go into the matter of setting the parts at considerable length in our Loom pamphlet, to which we refer those interested in such details. The following suggestions cover some of the more vital details:

For proper operation, the hopper must be positioned so as to deliver the bobbin, or cop skewer, properly into the shuttle. As left by our men, the position is correctly gauged. The lay bearings may change, however, and if there is any fault in the operation of changing filling, the loom should be turned over by hand, to note just where the fault is. Duplicate gauges should be kept by the overseer, by which to check up any errors in position. Note carefully the delivery of the new bobbin by the transferrer, to see that it is put properly into place, without any contact of the transferrer with the shuttle. The adjusting screw on the latch, attached to the transferrer, allows considerable lee-way for adjustment. If the lay does not come forward sufficiently, the throw may be set by the eccentric bearing at the lay end of the pitman. If the pitman becomes too badly worn to allow proper adjustment, it should be replaced. If a badly worn picker allows the shuttle to enter the box too far, an additional strip of leather should be placed in the box, behind the picker stick. It is better to keep the hopper continuously filled; that is, not allow gaps between the bobbins, although it may work all right without this care. The spring on the transferrer should

be set with sufficient tension to prevent the blow of the lay from forcing the bobbin too far in the shuttle, by extra momentum.

SHUTTLES.

If the shuttle spring gets loosened, tighten up the retaining screw. While this is a self-evident proposition, we have to call continual attention to it. With long bobbins, it is necessary to put some form of friction in the shuttle, such as bristles or slasher waste, inserted through holes in the sides. If the shuttle fails to thread, take pains to see whether the slot has become jammed, or the eye filled with lint. Shuttles often get broken because the protector is not properly set, allowing the side of the shuttle to be smashed in by the temple, when banging off. Another reason for shuttle splitting, is due to bobbins catching during transfer. This trouble is almost always due to improper position of the hopper, or to improper position of the shuttle with relation to the hopper. The shuttle position detector should protect one end, and the suitable insertion of leather back of the picker stick, the other end.

SETTING THE PICK.

Greater care than usual must be taken with the pick of the Northrop looms, for many serious troubles with the filling are due to a hard pick, which will not only tend to snap the filling thread when picking the shuttle, after transfer, but will also tend to make the filling throw off of the bobbin, loop over the eye point, or get caught in cracks or on projections near the shuttle box. A proper check will, of course, counteract the effect of a harsh pick, more or less, and so will a tight shuttle box. The proper method, however, is to use as light a pick as possible.

WARP-STOP MOTIONS.

Error in the warp-stop motion is easily detected by test with a dropped detector at various portions of the warp. Faults in action will be found due to improper set of parts, damaged parts, or worn parts. Necessary repairs should be promptly attended to. Slack threads often cause trouble by stopping the loom too often. This may be due to improper tension of the let-off, or the position of whip roll with relation to the harness. The greater part of warp breakage is due to knots, and especially knots with long ends.

CARE AND REPAIR.

Most of the trouble with a loom is due to lack of oiling and lack of care in keeping parts properly adjusted. There is so much jar and shock with this machine, that nuts are apt to

become loose, and bolts to slip. It is poor economy to allow badly worn parts to continue in use. If a change of goods is made, care must be taken to see that the let-off gearing is properly proportioned for the new work; also that the take-up shall let back the proper amount. The position of the take-up roller and whip roll with relation to the lay is of vital importance, necessarily changing as the conditions change. In order to get face on the goods, sacrifices must be made in other directions.

CLOTH DEFECTS.

If Northrop loom cloth shows warp runs or pick-outs, there is no excuse, as the warp-stop motion should properly protect against such errors. Thin places would prove either that the filling fork was out of order, or that the shuttle eye has become clogged so as to continue mis-threading, unless a dragging end of filling (when coarse) has held the fork from action. Thick places would be caused by the let-off not working properly, or by the take-up failing to act. Other general defects may be due to oil stains, which are inexcusable, poor set of pick or harness cams, need of friction in the shuttle, improper templing, improper choice of harness cams for the goods, and improper position of the parts over and through which the warp threads run.

SPEED RECOMMENDED FOR DRAPER LOOMS FOR MEDIUM WEIGHT GOODS.

28″	190 to 195	60″	128 to 132
30″	185 to 190	64″	124 to 128
32″	180 to 185	68″	120 to 124
34″	175 to 180	72″	116 to 120
36″	170 to 175	76″	112 to 116
38″	165 to 170	80″	108 to 112
40″	160 to 165	84″	104 to 108
42″	154 to 158	88″	100 to 104
44″	148 to 152	92″	96 to 100
46″	144 to 148	96″	94 to 96
48″	140 to 144	100″	90 to 94
52″	136 to 140	104″	88 to 90
56″	132 to 136	108″	86 to 88

There is no reason why our loom can not run at any speed attained by common looms of the same capacity. We never advocate extremes in this direction. In fact on heavy goods we would consider the above table too high.

NORTHROP LOOM DIMENSIONS.—E, D AND H MODELS.

Size.	Length of Lay for 14½ in. Shuttle. 6¾ in. Bobbin.	Length of Lay for 15⅝ in. Shuttle. 7⅞ in. Bobbin.	Length of Lay for 15⅝ in. Shuttle. 8 in. Bobbin.	Total Length of Harness Shaft.	Greatest Width of Cloth at Temple.	Proper Width Between Beam Heads.
28 in.	76 in.	77¼ in.	78½ in.	34 in.	31 in.	32 in.
30 in.	78 in.	79¼ in.	80½ in.	36 in.	33 in.	34 in.
32 in.	80 in.	81¼ in.	82½ in.	38 in.	35 in.	36 in.
36 in.	84 in.	85¼ in.	86½ in.	42 in.	39 in.	40 in.
40 in.	88 in.	89¼ in.	90½ in.	46 in.	43 in.	44 in.
50 in.	98 in.	99¼ in.	100½ in.	56 in.	53 in.	54 in.

Depth of Loom from full 18 inch Yarn Beam to 18 inch Cloth Roll: E Model, 50⅛; D and H Models, 53¼.
For proper width between Beam Heads we recommend 4 inches more than size of Loom. For those desiring extra space we supply Beams 5½ inches wider than size of Loom.

F MODEL LOOM DIMENSIONS.

Size.	Length Over All.	Available Space for Harness Shaft.	Greatest Width of Cloth at Temple.	Proper Distance Between Outside Heads of Yarn Beams.
72 in.	126 in.	79 in.	75 in.	78 in.
76 in.	130 in.	83 in.	79 in.	82 in.
82 in.	136 in.	89 in.	85 in.	88 in.
90 in.	144 in.	97 in.	93 in.	96 in.
100 in.	154 in.	107 in.	103 in.	106 in.

Largest diameter of Cloth Roll, 17 inches. Largest diameter of Yarn Beam, 16½ inches.
Largest distance between Beam Heads (outside Heads) 6 inches more than size of Loom.
Depth of Loom from full 16½ inch Yarn Beam to 17 inch Cloth Roll, 54⅝ inches. Use two Beams in a loom.

Although it could reasonably be assumed that all our readers fully comprehended the great advantages of the Northrop loom over the common loom, it might be well to say again, briefly, what no one has yet attempted to contradict publicly, namely; that with the Northrop loom a weaver can produce from two to four times as much cloth, using less skill, and at less expenditure of mental and physical energy.

The profits on the loom, irrespective of interest on investment, should run from $20 per year, upward. The saving in weaver's wages on a large grade of goods, is roughly figured at one cent per pound. There is no reason why the price paid per cut on goods woven by the Northrop loom should not be at least one-half that paid for weaving the same goods on the common loom. Ordinary weavers run 16 Northrop print, or sheeting, looms, good weavers run 20, and individual instances are known where 30 looms have been run, and with over 90 per cent. production. The fact that many mills show a record of 95 per cent. to 97 per cent. production on these looms, simply proves that the weavers are not given their full capacity.

So far as the question of first cost is concerned, the enormous demand for these looms seems to prove that purchasers are satisfied that they are worth the price asked. Compared with prices asked for other patented machinery improvements, the percentage of profit to the seller is most moderate. Cotton mill managers often buy an entirely new equipment of carding, or spinning machinery, to obtain the possible saving from new designs; but our loom makes a saving of more than the *entire labor expense* of either department. An invention that would entirely eliminate the card room, or the spinning room, would not surpass the effects of this loom on the industry at large.

WE DESIGNATE OUR DIFFERENT LOOM MODELS AS FOLLOWS:

A MODEL.—Like those at Queen City Mill and other early orders.

B MODEL.—Standard up to 1898.

D MODEL.—Heavy Pattern. Present standard.

E MODEL.—Regular Pattern. Present standard.

F MODEL.—Extra Heavy Pattern. Recommended for 72 inch goods and wider.

H MODEL.—Heavy Pattern. Side Cam Loom.

We will send diagrams of floor plan, if desired, after model is specified and questions answered.

SPECIFICATIONS OF NORTHROP LOOMS.

ORDERED FROM THE DRAPER COMPANY, HOPEDALE, MASS.

For.....Date..... 190

Total number..... Size ..... Model .....

..... Right-Hand Belt from above.
..... Left-Hand Belt from above.
..... Right-Hand Belt from below.
..... Left-Hand Belt from below.

Kind of cloth to be woven .....Width ..... Sley .....
Number of picks per inch .....
Number of threads in warp ..... No. of warp yarn.....
No. of filling yarn.....
Is filling on Bobbins or Cops?.....
Total length of Bobbin or Cop.....
What Let-off is required? .....
What Take-up is required? .....
Will you have Feeler? .....Right-Hand..... .....Left-Hand
How many harnesses are to be used?.....
How many up? ..... How many down? .....
How many harnesses are to be used?.....
How many up?..... How many down?.....
How many Harnesses are to be used?.....
How many up?..... .....How many down? .....
Is Selvage-motion required?..... .....Plain or Tape .....
What Warp Stop-motion is required?.....
How many Steel Heddles or Drop-wires are required?.....
What diameter and face of Driving Pulley.....
We furnish 16½ and 18 inch diam. Beam-heads, which do you require? ....Distance between heads.....
How many extra Shuttles do you require? .....
(One only included with each loom without extra cost.)
How many Filling Bobbins shall we order for you? .....
Shall they be Oil-filled?.....
What kind of Temples will you have? .....
What number of Harness shall we set up on?.....
.....Up .....Down .....
What number of Picks shall we set up on?.....
By what lines shall we ship?.....
REMARKS .....
.....
.....
.....
.....

INSTRUCTIONS FOR FILLING OUT SPECIFICATIONS.

(Make out separate specifications for each size loom.)

REED.—Send half a dozen pieces of different reeds, to help us fit lay. Reeds vary so much, one piece is not sufficient. As the contraction on our high roll take-up is considerably less, on certain classes of weaves, than on other looms, it would be well to write us before ordering new reeds. The maximum reed space is 5″ wider than the size of the loom.

BOBBIN OR COP.—It is necessary to send several sample cops with mule spindle, or bobbin and spindle. Our regular sizes of bobbins take 5 1-2, 6 1-8 and 6 3-4 inch traverse. Our regular cop sizes are 5 1-2, 6 1-8 and 6 3-4 inch traverse. Bobbins are patented, and must be ordered through us. At least 200 to a loom should be provided. When cops are used, we send twenty skewers with each loom. These are charged extra.

LET-OFF.—We furnish Bartlett, Shepard, Friction, or Bartlett and Friction combined. On F Model looms we furnish Compound let-off.

TAKE-UP.—Our "High Roll" construction admits of winding any diameter cloth roll up to 18 inches. Embodied with this we have three separate styles of Take-up.

Our regular pattern takes up with every pick, and lets back to prevent thin places.

Our Worm Take-up is a positive take-up, without the let-back feature, and is especially designed for corduroys, velvets and similar fabrics, which require 200 picks per inch and above.

Our Worm Take-up with Let-back is designed for those who require a positive take-up, and still desire the let-back feature.

HARNESS-MOTION.—We furnish the regular top harness-motion or the side-top compensating motion.

We also adapt our loom to take the Stafford or Crompton Dobby.

WARP STOP-MOTION.—We have three styles.

Steel harness for 2-shade work only, using one steel heddle for every warp thread.

Drop-wire stop-motion for cotton harness, which requires one drop-wire for every two warp threads in a two harness loom adapted for 2, 3, 4 and 5 harness work.

Single Thread or Lease Rod stop-motion for cotton harness, using one drop-wire for every warp thread. This stop-

motion is adapted for any number of harness from 2 up.

Drop-wires and heddles are extras, and should be ordered in sufficient quantities for extra drawing-in sets. It is well to order about 20 per cent. more drop-wires or heddles than the looms figure for this purpose.

PULLEYS.—Regular size 12 inch diameter, 2 ¼ inch face, for 28 inch loom. 14 inch diameter, 2 ¼ inch face, for 40 inch loom. We strongly recommend this width of face, as wider pulleys are much more troublesome in shifting belts.

EQUIPMENT.—We furnish looms with filling-changer, warp stop-motion, check stands, shuttle-guard, filling-forks, one shuttle, one and one-half beams per loom. No leather parts.

PICKERS.—Pickers must be of short pattern, not projecting above shuttle box. We furnish sample sets of strapping and pickers, without charge.

THE KEENE DRAWING-IN MACHINE.

We have just received patent protection on a design invented by Mr. W. L. Keene, of the Lockwood Company, Waterville, Maine, for a drawing-in frame with attachments for holding the warp, drop wires and harness, in a new and convenient manner, enabling the operative to draw in a much larger total of warp ends in a given time. There has been some objection to the use of warp-stop motions, in that they caused extra expense for drawing in; but this possible defect is largely obviated by this present invention. Its parts are made adjustable, and have a range so that they are applicable not only to all our various forms of warp-stop motion, but also for use with different numbers of harnesses. We make them in several widths, and will be glad to fill sample orders for trial. We have tested the idea thoroughly, in connection with our own little weave room, where we weave varied goods, with all manner of combinations of warp-stop motion and harness.

LOOM TEMPLES.

The object of a pair of temples is to keep the cloth at the proper width during the process of weaving, and also to prevent the warp from being drawn in or condensed near the selvages by the drag of the filling. The strain on the warp is so great that it is impossible to keep the cloth at the temple as wide as the space occupied by the warp in the reed. A good temple, however, will keep the cloth as near this width as is necessary. Modern requirements also demand self-action, adjustment, and freedom from accident and repairs.

The earliest invention in this line consisted of two flat pieces of wood with points set in one end of each. These were tied by a cord after being adjusted to the width of the goods, and were moved forward from time to time by the weaver. The next improvement was the jaw temple, on the same principle, made self-acting, however, by the motion of the lay. The first practical rotary temple was invented and introduced in this country by Ira Draper. This temple, as further improved by George Draper, went into extensive use, and even at the present time we are called upon to fill small orders of this type.

The next vital improvement was the reciprocating temple, invented by Mr. Warren W. Dutcher, for whom the Dutcher Temple Company is named. His inventions in temples and machinery for making them have developed so as to control the entire temple business of this country.

The original forms have been so greatly improved as to strengthen our hold on the trade, and it is doubtful if any temple not up to our present standard and infringing our present patents, would be used by manufacturers even if given away. A few yards of spoiled goods will make a pertinent argument for efficiency. We believe we can make perfect selvages on any goods without temple marks by use of one of our latest improvements and are ready to prove this assertion at any time. Mills are already familiar with some of our recent improvements, such as the oilless wooden roll bearing which cannot mark the cloth; the positive lock for the pod, preventing the roll teeth from ever striking the bar; the covered spring, and the metal adjustment plates. All these improvements make our temples more expensive to manufacture, and also make them more valuable to the manufacturer. We have not increased our prices, however, and trust the public will appreciate this fact.

We call attention to our breast beam plate, which, when

once attached to the loom, need never be moved, as the temple is adjusted on the plate and can accommodate all probable changes of width in goods woven. For woolen goods we have the Hardaker and Knowles patterns, both of which are extensively used. All our temples are made interchangeable and the workmanship and finish is of the usual Dutcher Temple Co. standard. This company manufactures all these styles of temples, and also nearly a hundred other patterns which have been introduced at different periods, and are still used by mills that have grown accustomed to old styles and send duplicate orders. As we know our present patterns are much more efficient, we discourage such a course whenever possible. We only illustrate our present improved types.

TEMPLE ROLLS.

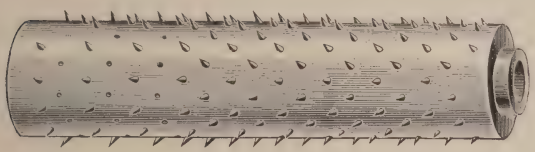
The roll is the vital feature of a temple, and is the main point to be considered in deciding what temple shall be used. We have evolved many different styles to accommodate the great variety in cloth woven. If trouble is encountered in any mill, we will be glad to send our expert to advise on the difficulty. Our rolls are divided into several classes. We have two regular lengths, and can make a third by doubling our short length. Our rolls usually have the same diameter for the outside tooth circle, but the wood is turned in various diameters in order to allow the points of the teeth to project varying distances. A feature used for certain goods is our taper set, by which the teeth project farther at the selvage. Another feature is used sometimes on the selvage end of the roll, and consists in having half the usual number of teeth. These modifications are patented, and have proved very important in preventing temple marks on certain goods. Our rolls are also divided in two classes, as follows, which divisions, however, have nothing to do with the effect on the cloth. Our latest improved style has a wood bushing inserted at each end to run on gun-metal pins. These bushings are prepared with an anti-friction compound and will not require oil. This point is very important, as it absolutely prevents marks on the cloth from this source. These rolls cannot be put in wrong end foremost, which fact prevents a former common mistake. Our old style roll has a center hole running its entire length to serve as a bearing for a long roll pin, and we do not recommend these to be run without oiling.

Our regular line of rolls is shown in the following list. It does not pretend to show every modification, however, as it is to be understood that these rolls are made with varying diameters, and each style of roll can be adapted for either style of bearing. We show the most used forms in the cuts. We usually select the rolls ourselves when filling temple orders, being guided by the cloth specified. Our customers may wish to choose for themselves, however, in which case, of course, our responsibility ends. The numbers have been changed from those given in our former catalogue.

Short rolls are 1 3-4 inches long. Long rolls are 2 1-2 inches long.

LONG ROLLS.

No. 464.

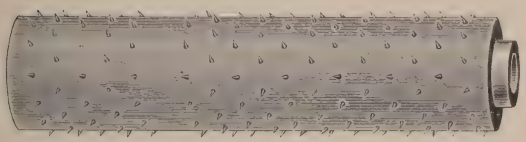


NAME—Eureka No. 1, small dia. roll, taper set, half number of teeth on selvage, wood bushings.

USE—This is a standard pattern for all medium grades of goods, 36 to 40 and above. Used regularly in our No. 76 temple.

VARIATIONS—Also made with center hole for long bearing.
Also made large diameter.
Also made with full number of teeth on selvage.

No. 470.



Like No. 464 but made with row of teeth omitted for use with wired pod as shown.

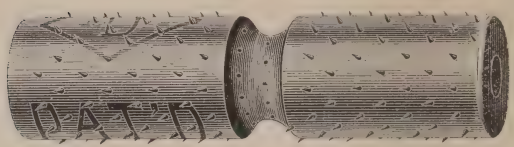
No. 410.

NAME—Eureka No. 1, grooved, small dia. roll, taper set, wood bushings.

USE—For ordinary sheetings or shirtings.

VARIATIONS—Also made with center hole for long bearing.
Also made large diameter.
Also made with half number of teeth on selvage.

No. 301.

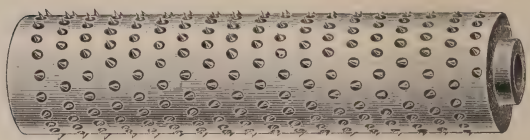


NAME—Eureka No. 1, grooved, large dia. roll, long bearing.

USE—For fine sheetings and shirtings.

VARIATIONS—Also made with wood bushings.
Also made small diameter.

No. 364.



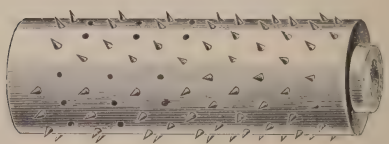
NAME—Special Eureka No. 1, roll. Large diameter with double number teeth, taper wood bushing.

USE—For very fine goods.

VARIATIONS—Also made with long bearing.

SHORT ROLLS.

No. 120.



NAME—Small dia. roll, taper set, half number teeth on selvage, wood bushings.

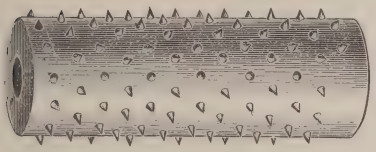
USE—For narrow goods.

VARIATIONS—Also made for long bearing, as in No. 24 on next page.

No. 24.

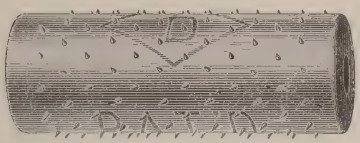
Also made large diameter.
Also made with full number of teeth on selvage.

No. 101.



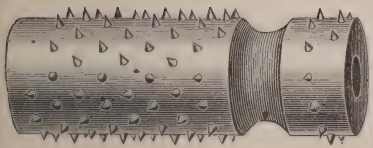
NAME—Common, small dia. roll, long bearing.
USE—For prints, etc.
VARIATIONS—Also made with wood bushings.
Also made large diameter, as in No. 1 below.

No. 1.

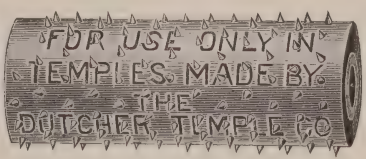


DOUBLE ROLL.

No. 105.

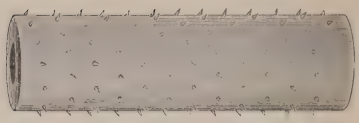


No. 101.



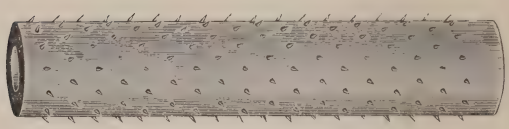
NAME—Eureka No. 2 double roll.
USE—For very heavy or very wide goods with No. 84 or No. 85 temple.

No. 604.



NAME—Small ½ inch dia. roll for No. 107 temple.
This style uses two of this roll No. 604 and two of roll No. 602 with each temple.

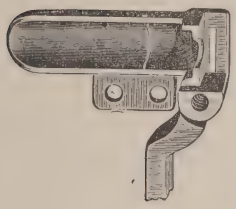
No. 602.



NAME—Small ½ inch dia. roll of longer pattern for Nos. 107 and 108 temple.
Two used with each temple.

All temple rolls manufactured by the Draper Co. are marked with their trade-mark, which has been duly registered at the Patent Office, together with the statement:

"FOR USE ONLY IN TEMPLES MADE BY THE DRAPER COMPANY."

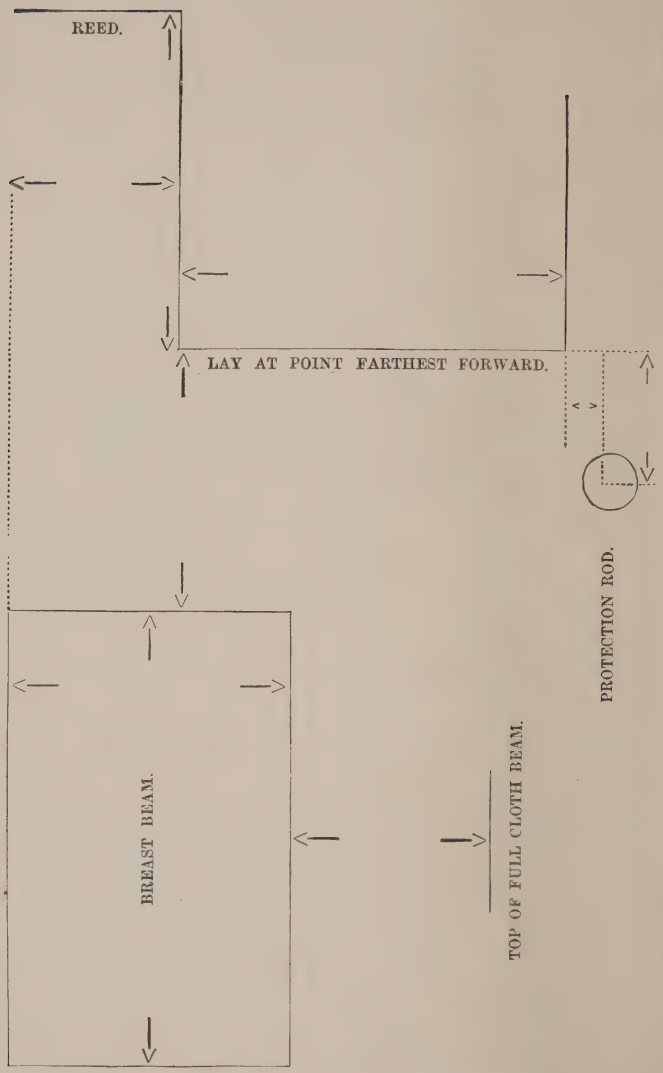


One of our most recent temple improvements consists in the application of a small bent wire to the pod of the bar as shown, to engage the cloth and hold it better, the roll having a row of teeth omitted at this point as shown in No. 470 roll. This has been found of great utility in preventing temple marks on fine goods.

Apart from the roll, the rest of the temple varies in form to suit the customer. Some mills prefer spring temples, and others hinge temples. Hinge temples cannot be used on Northrop Looms of our make. The regular reciprocating styles Number 76 or 78, are at present most popular on account of recent improvements.

Many mills persistently order old styles of temples, which we do not now recommend. We can, of course, supply them, but there is no reason why the mill should handicap itself in this way. Wear, repairs and *effects* are all strongly in favor of the recent patterns.

In ordering, note carefully the specification on next page. We have so many styles that it is necessary when ordering temples of old patterns or repair parts for same to send samples.



SPECIFICATION FOR PATENT LOOM TEMPLES.

Give measurement in inches between all points indicated.

Number of Looms. Maker of loom. Kind of temple.

Breast beam of iron or wood. Kind of goods woven.

Give diameter and position of any rods between breast beam and lay, or within two inches of underside of lay or breast beam.

Blank specification will be sent on application.

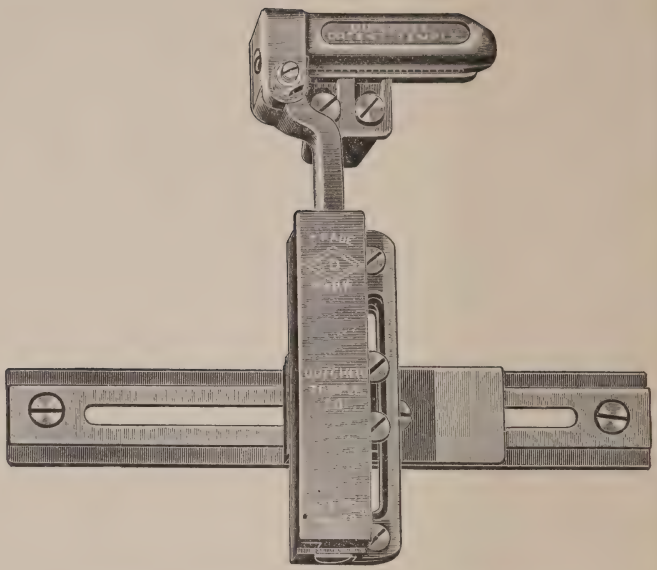
NAMES OF PRESENT STANDARD PATTERNS SHOWN IN FOLLOWING PAGES.

No. 76 and 76½ Dutcher Temple.
No. 78 and 78½ Dutcher Temple.
No. 76 and 76½ Dutcher Thread-Cutting Temple.
No. 78 and 78½ Dutcher Thread-Cutting Temple.
No. 103 Dutcher Thread-Cutting Temple.
No. 104 Dutcher Thread-Cutting Temple.
No. 111 Dutcher Thread-Cutting Temple.
No. 113 Dutcher Thread-Cutting Temple.
Dutcher Hinge Temple, 1894 pattern.
No. 87 Dutcher Spring Temple.
No. 88 Dutcher Spring Temple.
No. 89 Dutcher Spring Temple.
No. 84 Dutcher Temple.
No. 85 Dutcher Temple.
Dutcher Gingham Temple.
No. 107 Dutcher Temple.
No. 108 Dutcher Temple.
No. 131 Dutcher Temple.
Hardaker Patent Temple.
Knowles Patent Temple.

The first nine are fitted with either wood bushed rolls or center bearing as desired. Nos. 84, 85, 107 and 108, always have long center bearing.

TEMPLES FOR NORTHROP LOOMS.

Our earlier patterns of loom, made without the high roll take-up, use regular temples Nos. 76, 76½, 78 and 78½ with thread cutting temples on the hopper side. The temples used with the high roll take-up have parts similar in purpose to those of the former patterns, but some of them are necessarily different in shape. In ordering repairs, remember that those temples now out have numbers 103 corresponding to No. 78 temple, and 104 corresponding to No. 76 temple.



DUTCHER PATENT NO. 76 AND 76½ TEMPLE.
(Shown with Honan Plate. Can be had without but the Honan is best.)

Dutcher Patent No. 76½ Temple has similar parts to No. 76 except that the bar is longer, which makes it especially adaptable for looms with wooden breast beams.

TECHNICAL NAMES OF PARTS.

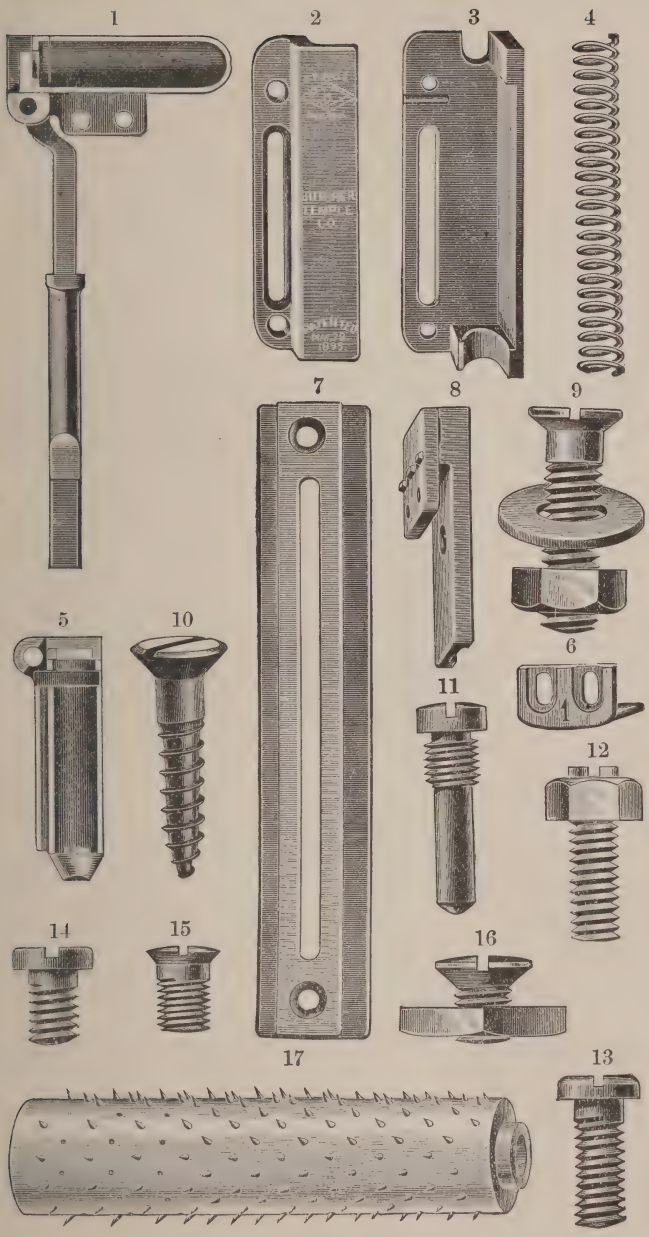
1. Bar.
2. Cap.
3. Stand.
4. Spring.
5. Top.
6. Heel.
7. Base Plate.
8. Honan Plate Slide.
9. Plate Bolt, Nut and Washer for Iron Beam.
10. Plate Screw for Wood Beam.
11. Roll Pin.
12. Top Screw.
13. Stand Screw.
14. Heel Screw.
15. Cap Screw.
16. Slide Screw and Nut.
17. Roll.

Parts 5, 6, 7, 8, and 17 are made in different shapes and sizes, and must be ordered by sample or by number on pattern. The rest can be ordered by this list, as "*Left Bar for No. 76 Temple.*"

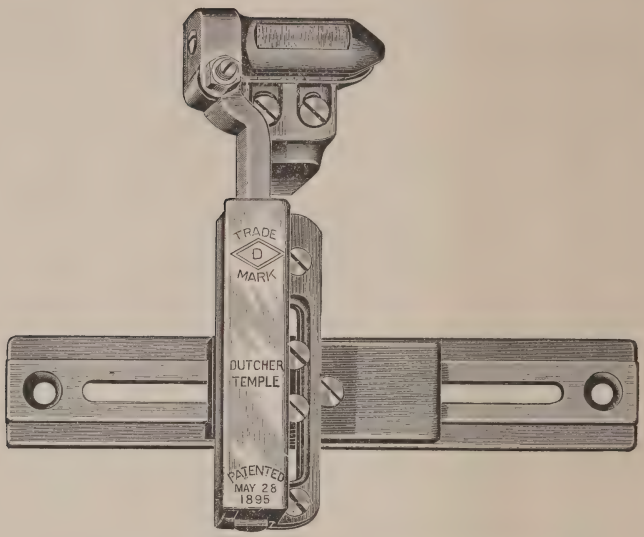
Parts 1, 2, 3, 5 and 8 are made rights and lefts.

Parts 1 to 8 are shown one-third size.

Parts 9 to 17 are shown full size.



PARTS OF NO. 76 and 76½ TEMPLE.



DUTCHER PATENT NO. 78 AND 78½ TEMPLE.

(Shown with Honan Plate. Can be had without but the Honan is best.)

Dutcher Patent No. 78½ Temple has similar parts to No. 78, except that the bar is longer, which makes it especially adaptable for looms with wooden breast beams.

TECHNICAL NAMES OF PARTS.

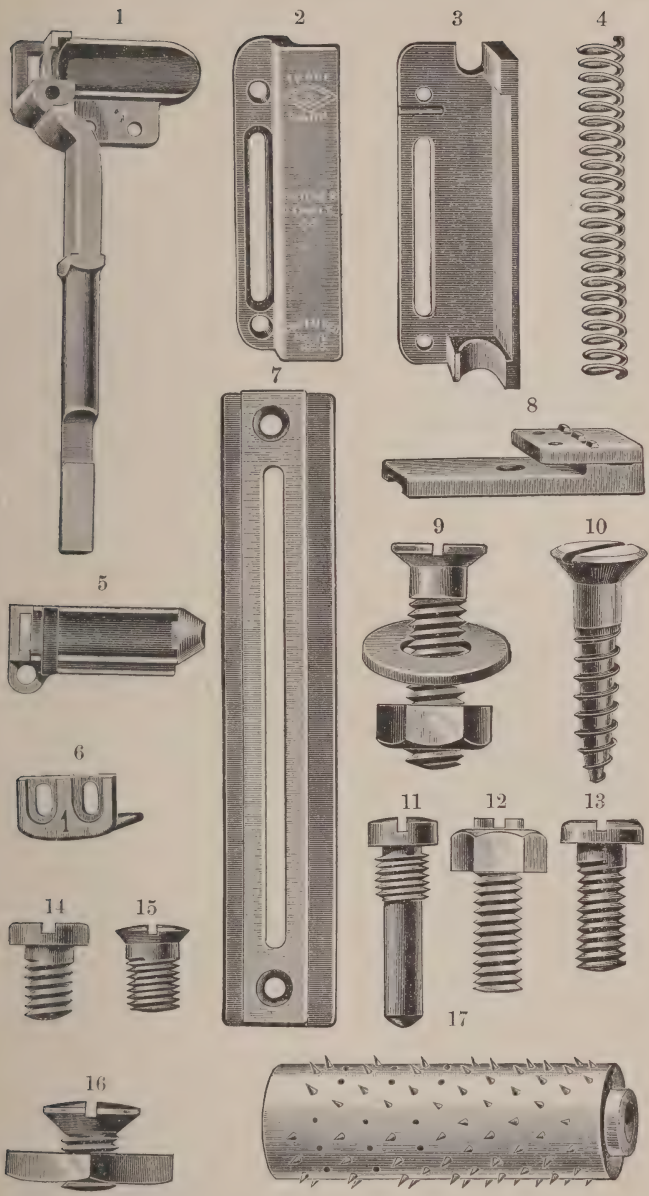
1. Bar.
2. Cap.
3. Stand.
4. Spring.
5. Top.
6. Heel.
7. Base Plate.
8. Honan Plate Slide.
9. Plate Bolt, Nut and Washer for Iron Beam.
10. Plate Screw for Wood Beam.
11. Roll Pin.
12. Top Screw.
13. Stand Screw.
14. Heel Screw.
15. Cap Screw.
16. Slide Screw and Nut.
17. Roll.

Parts 5, 6, 7, 8 and 17 are made in different shapes and sizes, and must be ordered by sample or by number on pattern. The rest can be ordered by this list, as "*Left Bar for No. 78 Temple.*"

Parts 1, 2, 3, 5 and 8 are made rights and lefts.

Parts 1 to 8 are shown one-third size.

Parts 9 to 17 are shown full size.

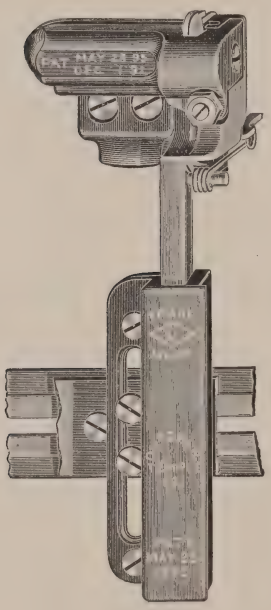


PARTS OF DUTCHER NO. 78 and 78½ TEMPLE.

NOS. 76, 76½, 78 AND 78½ THREAD-CUTTING TEMPLE WITH HONAN PLATE.

Technical Names of Parts.

Nos. 76½ and 78½ Thread-Cutting Temples have longer bars than Nos. 76 and 78. None of these numbers apply to temples used on our later forms of Northrop Looms having the High Roll Take-Up. Those are numbered Nos. 103-104, and for a heavy model loom are numbered 111 and 113. (See page 268.)



1A. Bar for 78 Thread-Cutting Temple.
1B. Bar for 76 Thread-Cutting Temple.
2. Cap.
3. Stand.
4. Spring.
5A. Top for 78 Thread-Cutting Temple.
5B. Top for 76 Thread-Cutting Temple.
6. Heel.
7. Base Plate.
8. Honan Plate Slide.
9. Plate Bolt, Nut and Washer for Iron Breast Beam.
10. Plate Screw for Wood Beam.
11A. Roll Pin for outer end of Thread-Cutting Temple.
11. Roll Pin for inner end of Thread-Cutting Temple.
12. Top Screw for-Thread Cutting Temple.
13. Stand Screw.
14. Heel Screw.
15. Cap Screw.
16. Slide Screw and Nut.
17. Roll for 78 Temple. } Send
18. Roll for 76 Temple. } sample.
19. Cutter Spring.
20. Knife.

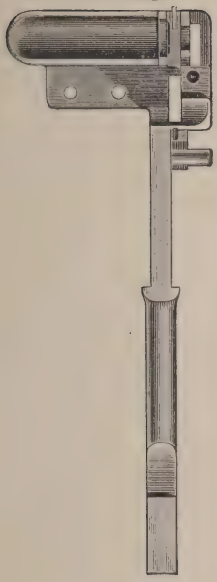
Parts 5, 6, 7, 8, 17 and 18 are made in different shapes and sizes, and must be ordered by sample or by number on pattern. The rest can be ordered by this list as "*Left Bar for No. 78 Thread-Cutting Temple.*"

Parts 1, 2, 3, 5, 8, 19 and 20 are made rights and lefts.

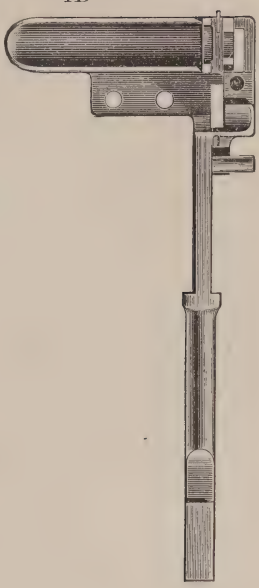
Parts 1 to 8 are shown one-third size.

Parts 9 to 20 are shown full size.

1A

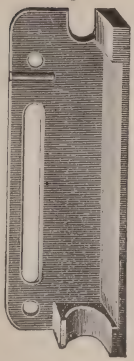


1B

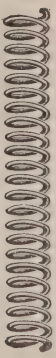


2

3



4

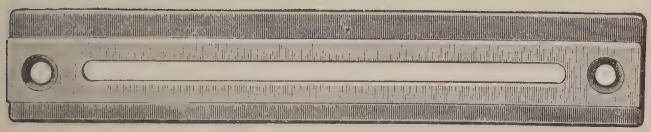


5A

5B

6

7



NOS. 76, 76½, 78 AND 78½ THREAD-CUTTING TEMPLE.

TECHNICAL NAMES OF PARTS ON OPPOSITE PAGE.

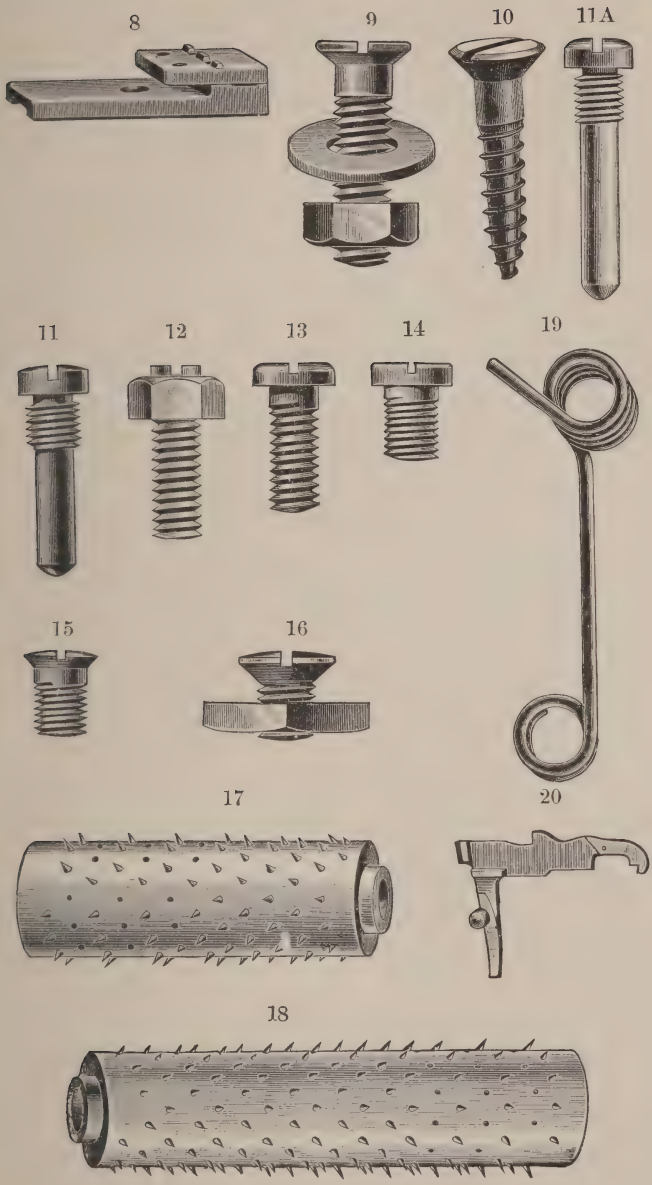
(See total list on page 264.)

8. Honan Plate Slide.
9. Plate Bolt, Nut and Washer for Iron Breast Beam.
10. Plate Screw for Wood Beam.
11A. Roll Pin for outer end of Thread-Cutting Temple.
11. Roll Pin for inner end of Thread-Cutting Temple.
12. Top Screw for Thread-Cutting Temple.
13. Stand Screw.
14. Heel Screw.
15. Cap Screw.
16. Slide Screw and Nut.
17. Roll for 78 Temple.
18. Roll for 76 Temple.
19. Cutter Spring.
20. Knife.

TEMPLES FOR HIGH ROLL TAKE-UP NORTHROP LOOMS.

Nos. 103 and 104 have the same parts as these shown so far as function and general appearance are concerned. We therefore have not thought it necessary to illustrate them.

Same applies to Nos. 111 and 113.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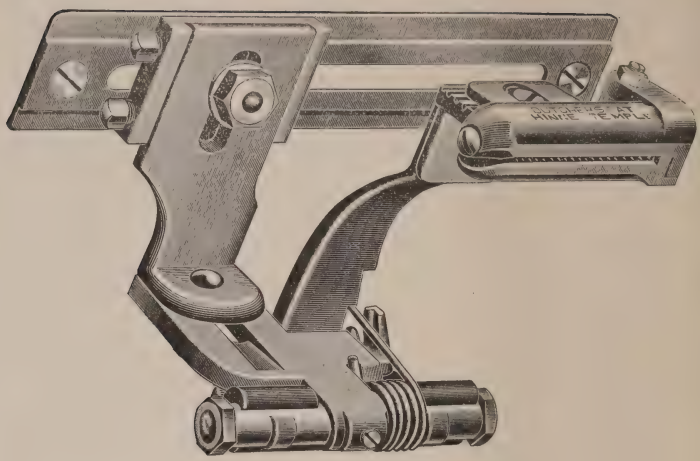


DUTCHER PATENT HINGE TEMPLE, 1894 PATTERNS.

TECHNICAL NAMES.

1. Swing.
2. Base Plate.
3. Extension.
4. Stand.
5. Extension Pin.
6. Slide.
7. Pod.
8. Top.
9. Spring.
10. Heel.
11. Roll.
12. Nut for Extension Pin.
13. Bearing.
14. Stand Bolt, nut and washer.
15. Stand Screw and Washer.
16. Bolt, Nut and Washer for Iron Breast Beam.
17. Screw for Wood Breast Beam.
18. Roll Pin.
19. Top Screw.
20. Slide Screw.
21. Pod Bolt and Nut.
22. Extension Pin Screw.
23. Heel Screw.

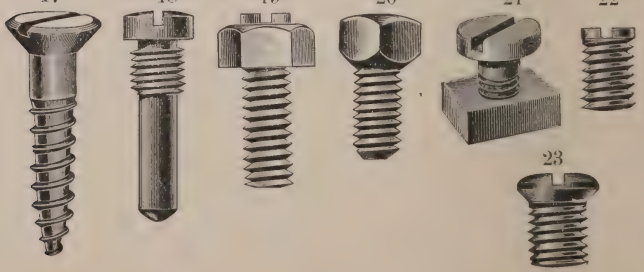
Parts 1, 2, 3, 4, 7, 8, 9, 10 and 11 are made in different shapes and sizes. They must be ordered by sample or by number on pattern.

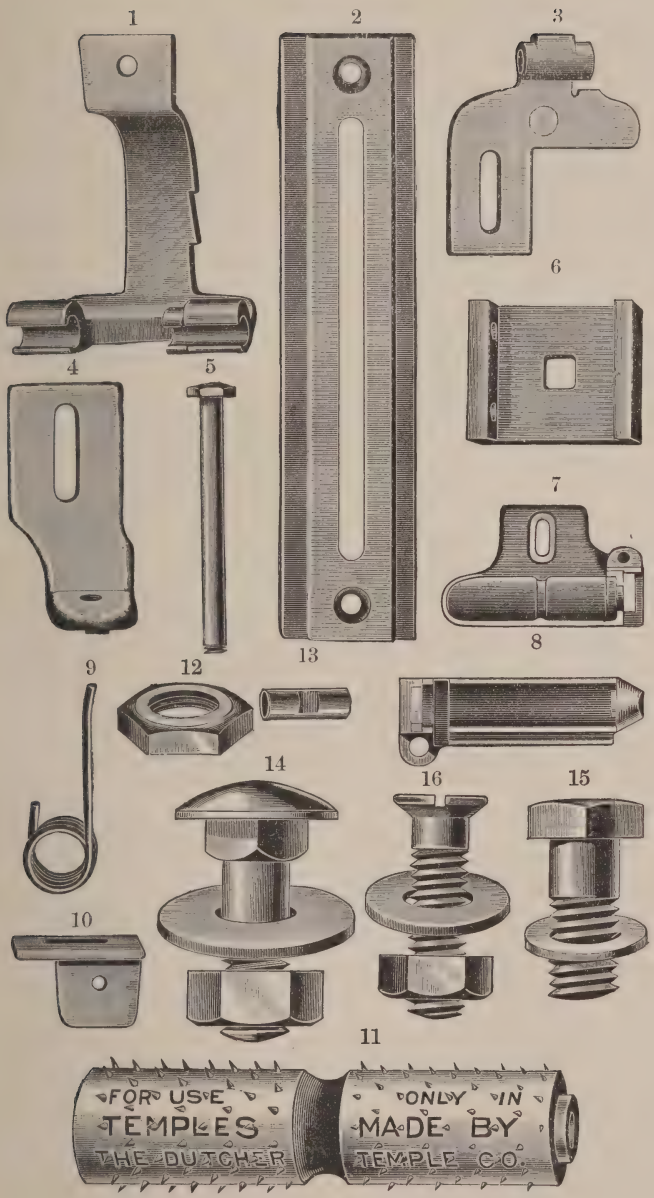
The rest can be ordered by this list, as, "*Bearing for 1894 Hinge Temple.*"

Specify Rights and Lefts when necessary.

Parts 1 to 10 and 13 are shown one-third size.

Parts 11 to 23, except 13, are shown full size.





PARTS OF DUTCHER HINGE TEMPLE, 1894 PATTERN.

DUTCHER PATENT SPRING TEMPLE NO. 87.

Also made in styles Nos. 88 and 89, distinguished by different lengths of heel.

PATENTED MAY 28, 1895.

Spring 17 inches long with 1 inch offset unless otherwise specified.

Face plates to carry spring forward from 3-4 to 1 3-4 inches.

TECHNICAL NAMES OF PARTS.

1. Spring.
2. Face Plate.
3. Top Plate.
4. Pod.
5. Top.
6. Heel and Plate Clamp.
7. Heel.
8. Face Plate Screw and Washer.
9. Top Plate Screw.
10. Roll Pin.
11. Plate Clamp Screw and Washer.
12. Top Screw.
13. Heel Screw.
14. Plate Bolt Nut and Washer for Iron Breast Beam.
15. Roll.

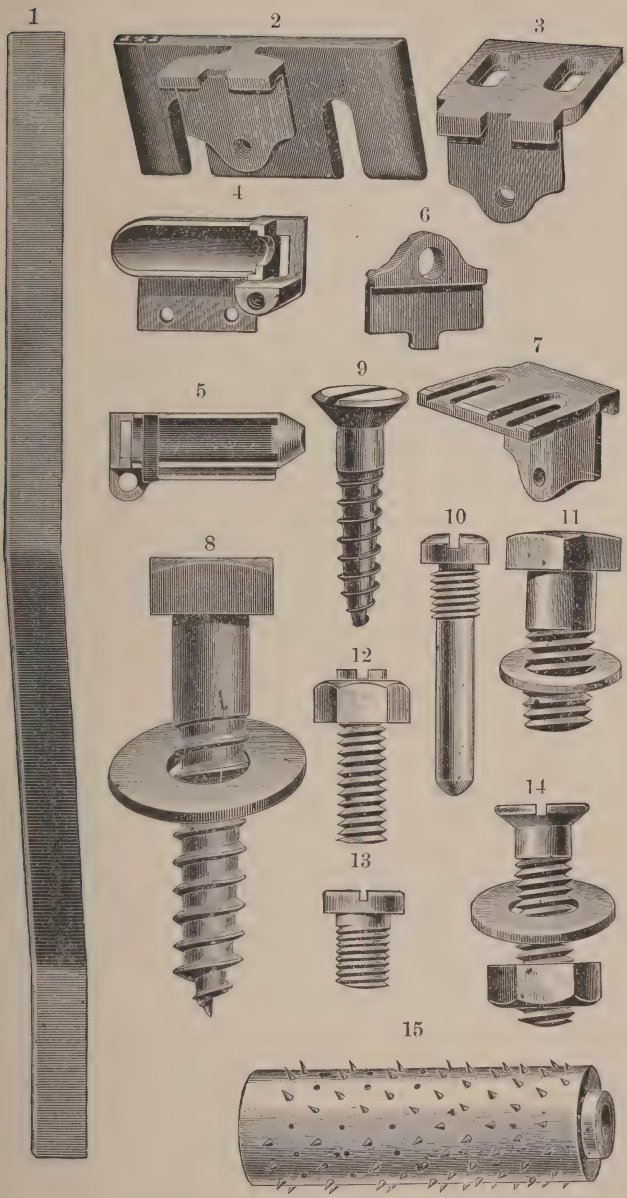
Parts 1, 4, 5, 7 and 15 are made in different shapes and sizes, and must be ordered by sample or by number on pattern. The rest can be ordered by this list, as, "*Face Plate for* 87 *Spring Temple.*"

Parts 4 and 5 made in rights and lefts.

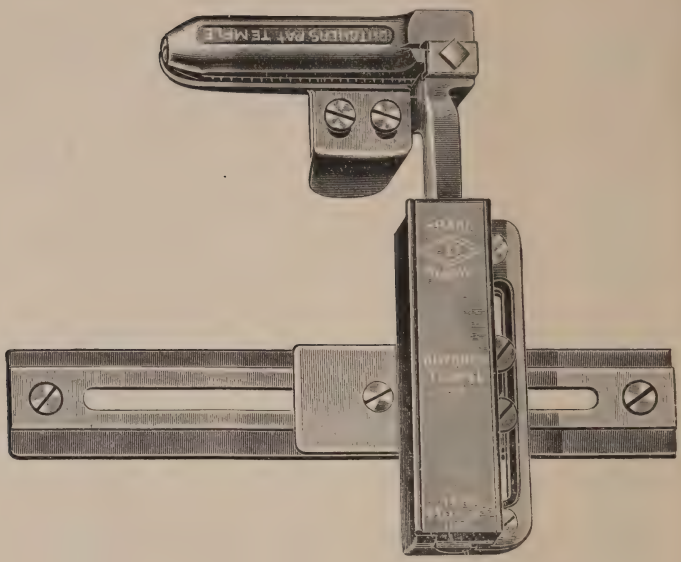
Parts 1—7 shown 1–3 size.

Parts 8—15 shown full size.

Also made with long roll.



PARTS OF DUTCHER PATENT SPRING TEMPLE NO. 87.



DUTCHER NO. 82, 84, OR 85 TEMPLE.

(Shown on Honan Plate.)

No. 82 has bar 8 inches long.
No. 84 has bar 9 inches long.
No. 85 has bar 10 inches long.

TECHNICAL NAMES OF PARTS.

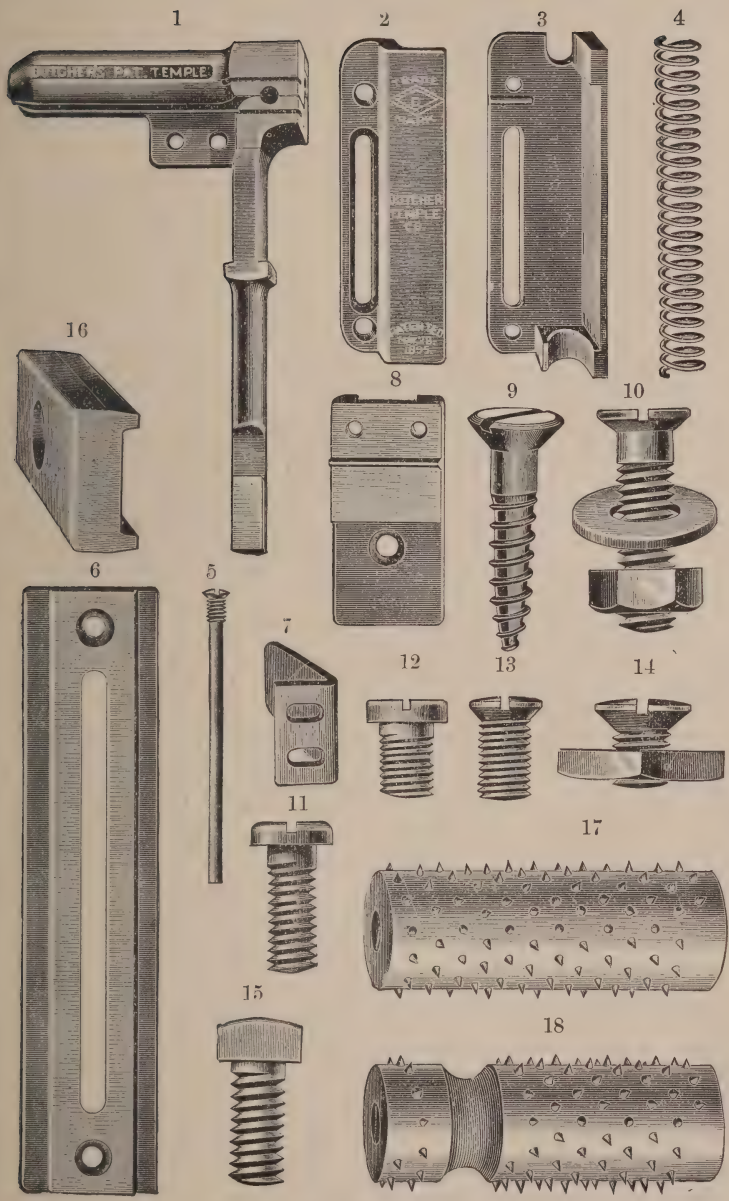
1. Bar and Top.
2. Cap.
3. Stand.
4. Spring.
5. Roll Pin.
6. Base Plate.
7. Heel.
8. Slide.
9. Plate Screw for Wood Beam.
10. Plate Bolt, Nut and Washer for Iron Beam.
11. Stand Screw.
12. Heel Screw.
13. Cap Screw.
14. Slide Screw and Nut.
15. Top Screw.
16. Top screw lock.
17. Inner Roll.
18. Selvage Roll.

Parts 1, 6, 7, 8, 17 and 18 are made in different shapes and sizes and must be ordered by sample or by number on pattern. The rest can be ordered by this list, as, "*Stand for left hand, No. 84 Temple.*"

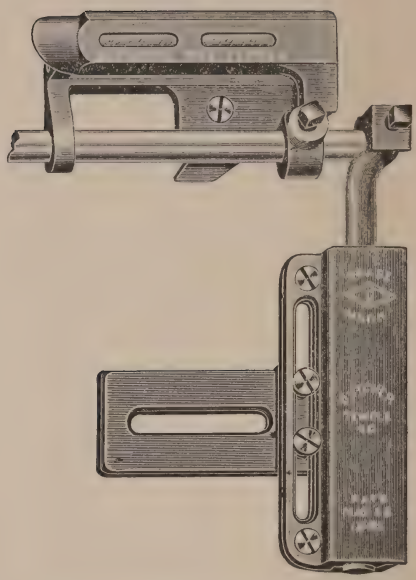
Parts 1, 2, 3 and 8 are made rights and lefts.

Parts No. 1 to 8 shown one-third size.

Parts 9 to 18 shown full size.



PARTS OF NO. 84 OR 85 TEMPLE.



DUTCHER PATENT TEMPLE FOR GINGHAM LOOMS.

TECHNICAL NAMES OF PARTS.

1. Bar.
2. Cap.
3. Stand.
4. Spring.
5. Top.
6. Heel.
7. Base Plate.
8. Pod Extension.
9. Rod.
10. Plate Screw for Wood Beam.
11. Roll Pin.
12. Top Screw.
13. Stand Screw.
14. Heel Screw.
15. Cap Screw.
16. Inner Roll.
17. Outer Roll.

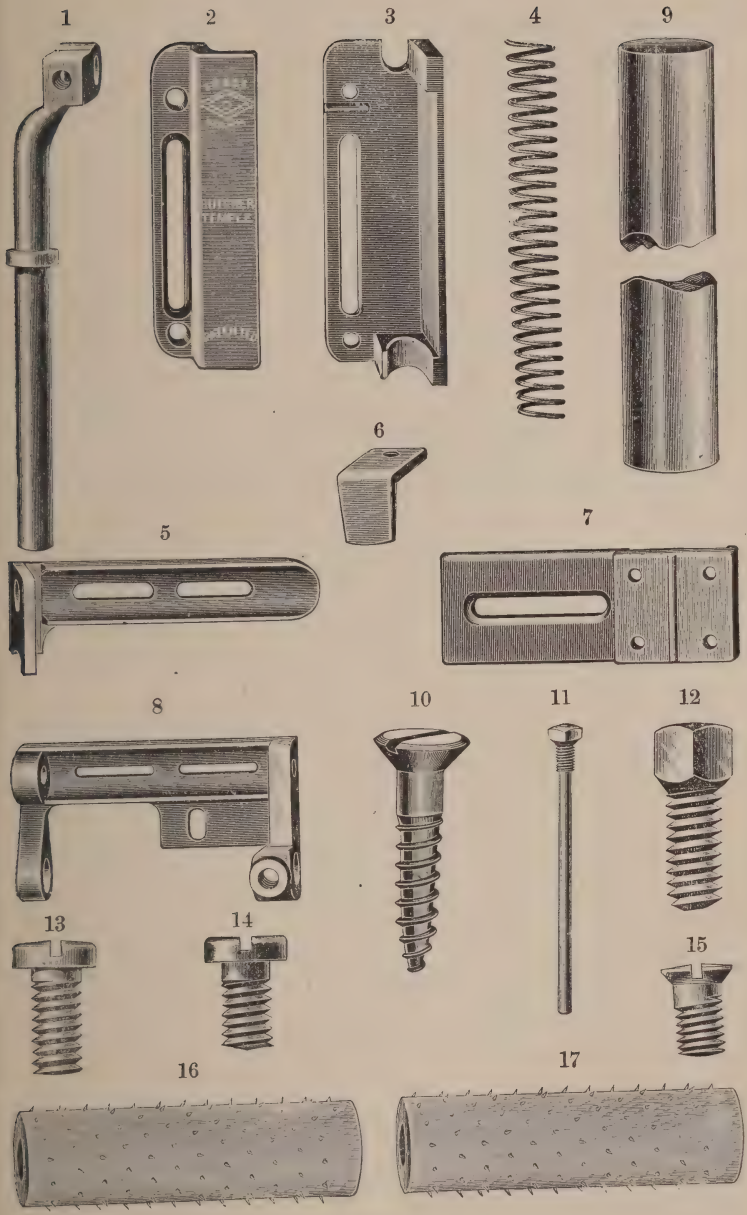
Parts 6, 7, 9, 16 and 17 are made in different shapes and sizes, and must be ordered by sample or by number on pattern. The rest can be ordered by this list as "*Left Bar for No. 100 Temple.*"

Parts 1, 2, 3, 5, 7 and 8 are made rights and lefts.

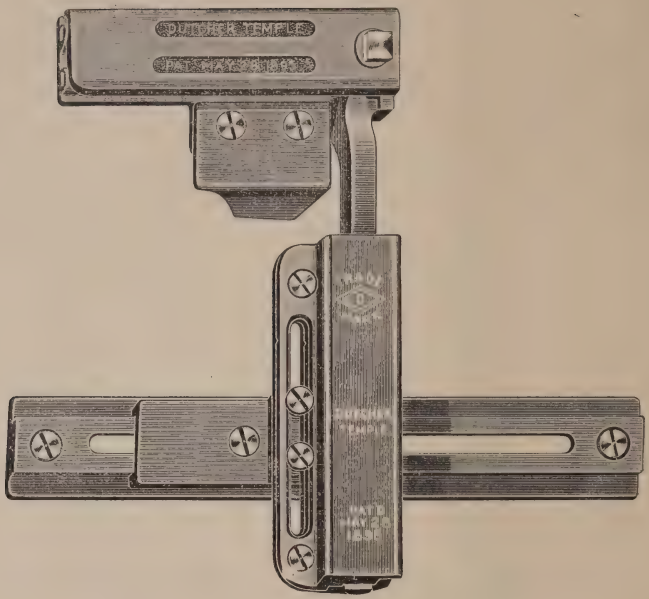
Parts 1 to 8 and 11 are shown one-third size.

Parts 9 to 17 (except 11) are shown full size.

This temple is usually applied to wooden breast-beams. If made for iron beams it would have Plate Slide and Plate Bolt like other varieties shown.



PARTS OF GINGHAM TEMPLE.



DUTCHER PATENT NO. 107 TEMPLE.
Shown on Honan Plate.

TECHNICAL NAMES OF PARTS.

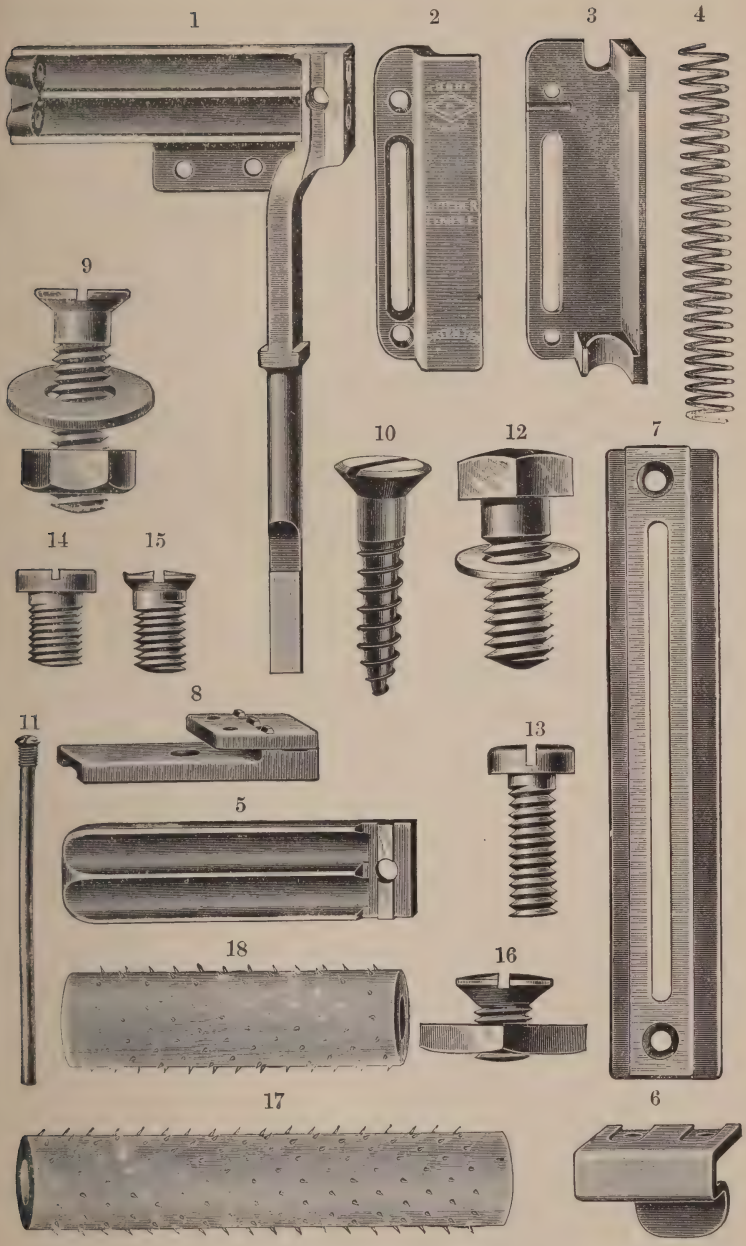
1. Bar.
2. Cap.
3. Stand.
4. Spring.
5. Top.
6. Heel.
7. Base Plate.
8. Honan Plate Slide.
9. Plate Bolt, Nut and Washer for Iron Beam.
10. Plate Screw for Wood Beam.
11. Roll Pin.
12. Top Screw and Washer.
13. Stand Screw.
14. Heel Screw.
15. Cap Screw.
16. Slide Screw and Nut.
17. Long roll.
18. Short roll.

Parts 6, 7, 8, 17 and 18 are made in different shapes and sizes and must be ordered by sample or by number on pattern. The rest can be ordered by this list as "*Left Top for No. 107 Temple.*"

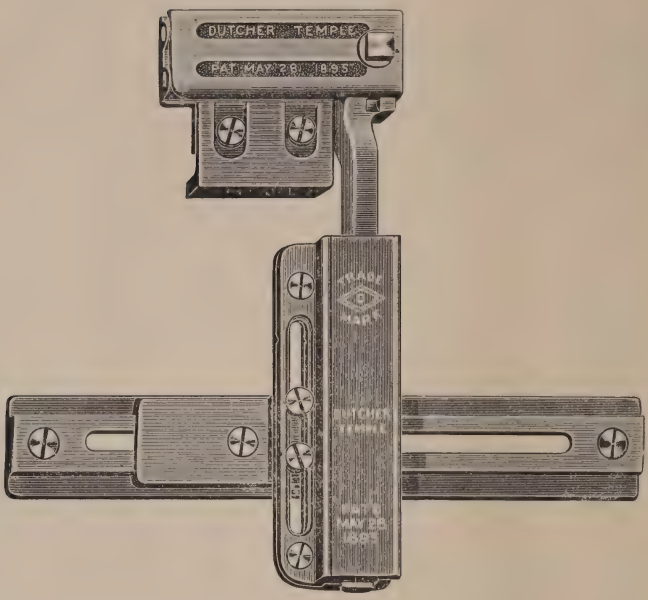
Parts 1, 2, 3, 5 and 8 are made rights and lefts.

Parts 1 to 8 and 11 are shown one-third size.

Parts 9 to 18 (except 11) are shown full size.



PARTS OF NO. 107 TEMPLE.



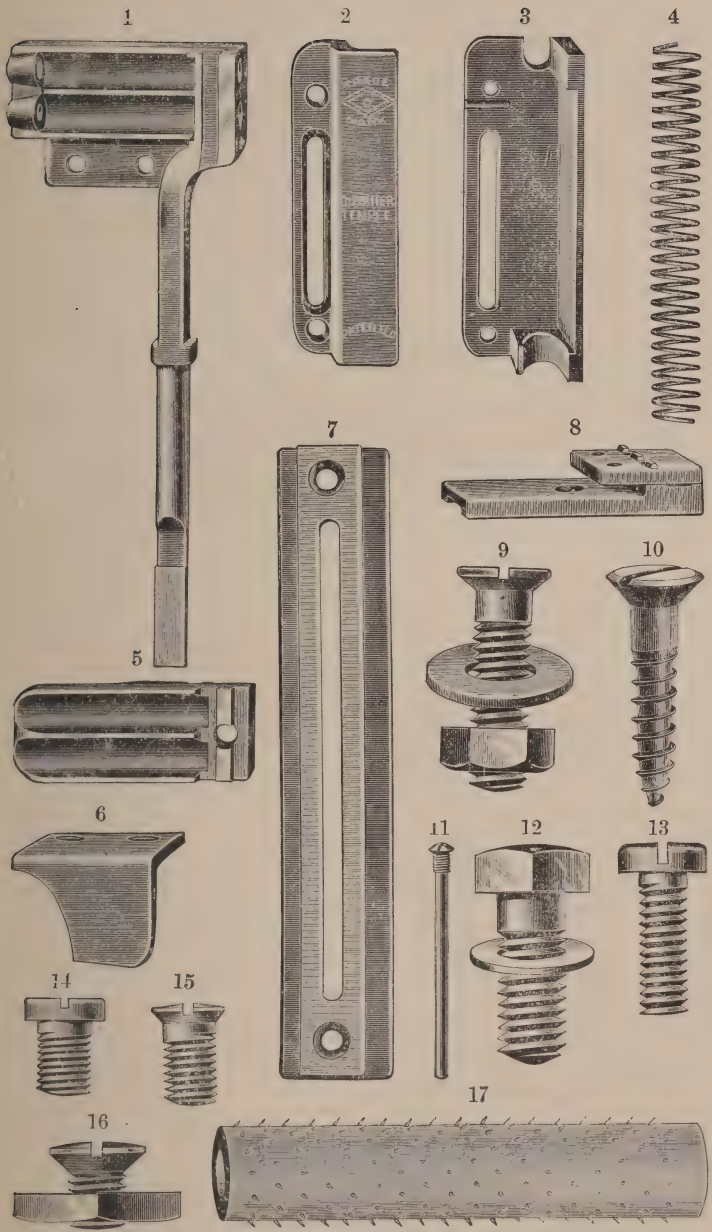
DUTCHER PATENT NO. 108 TEMPLE.
Shown on Honan Plate.

TECHNICAL NAMES OF PARTS.

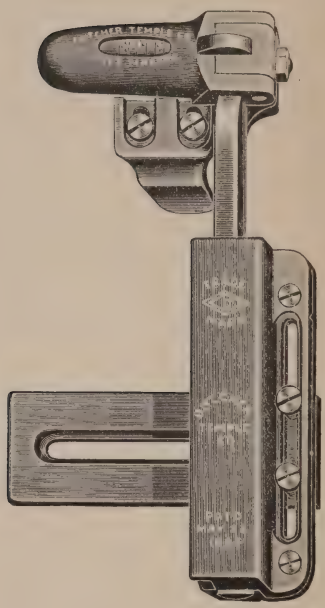
1. Bar.
2. Cap.
3. Stand.
4. Spring.
5. Top.
6. Heel.
7. Base Plate.
8. Honan Plate Slide.
9. Plate Bolt, Nut and Washer for Iron Beam.
10. Plate Screw for Wood beam.
11. Roll Pin.
12. Top Screw and washer.
13. Stand Screw.
14. Heel Screw.
15. Cap Screw.
16. Slide Screw and Nut.
17. Roll.

Parts 6, 7, 8 and 17, are made in different shapes and sizes and must be ordered by sample or by number on pattern. The rest can be ordered by this list, as "*Left Top for No. 108 Temple.*"

Parts 1, 2, 3, 5 and 8 are made rights and lefts.
Parts 1 to 8 and 11 are shown one-third size.
Parts 9 to 17 (except 11) are shown full size.



PARTS OF NO. 108 TEMPLE.



DUTCHER PATENT NO. 131 TEMPLE.

TECHNICAL NAMES OF PARTS.

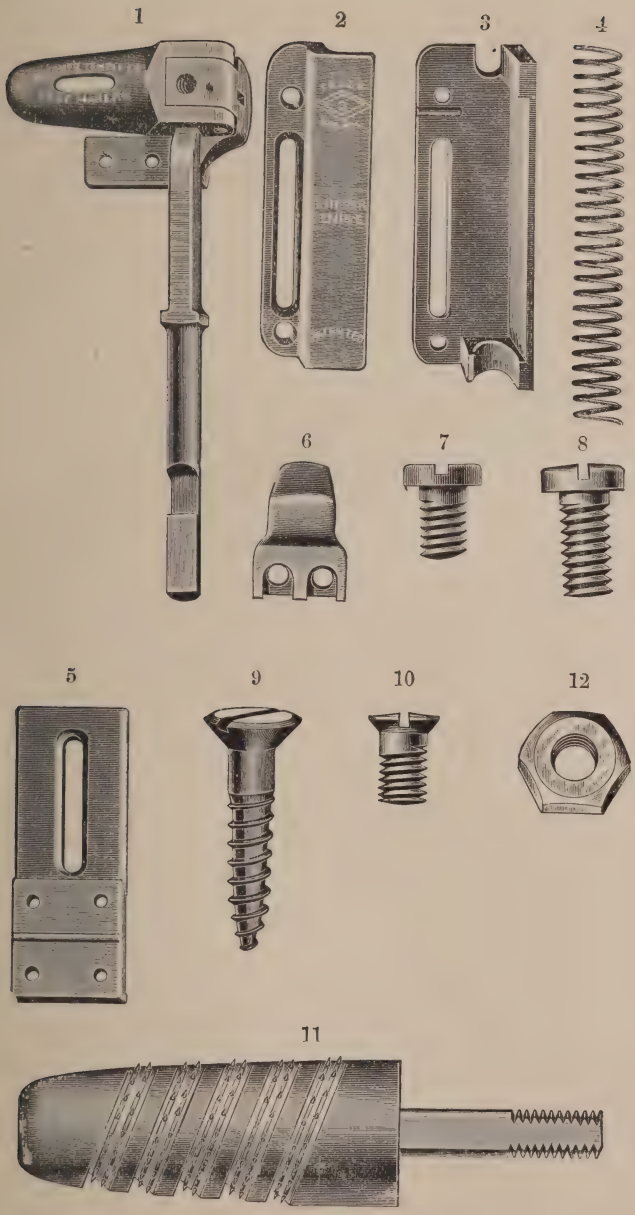
1. Bar and Top.
2. Cap.
3. Stand.
4. Spring.
5. Base Plate.
6. Heel.
7. Heel Screw.
8. Stand Screw.
9. Plate Screw for Wood [Beam.
10. Cap Screw.
11. Roll.
12. Roll Nut.

Parts 5 and 6 are made in different shapes and sizes and must be ordered by sample or by number on pattern. The rest can be ordered by this list as "*Roll Nut for No. 131 Temple.*"

Parts 1, 2 and 3 are made rights and lefts.

Parts 1 to 6 are shown one-third size.

Parts 7 to 12 are shown full size.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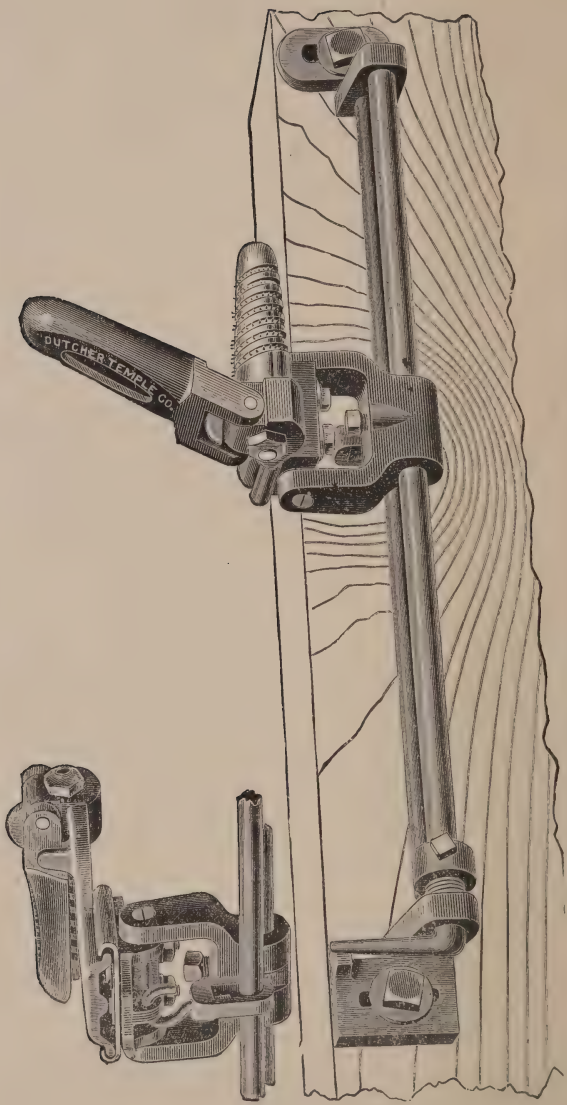


HARDAKER'S PATENT TEMPLE FOR WOOLEN AND WORSTED FABRICS.

HARDAKER'S PATENT TEMPLE FOR WOOLEN AND WORSTED FABRICS.

In weaving the heavier kinds of woolen and worsted goods, there is in almost all looms a considerable horizontal and vertical movement of the cloth; and the temple that offers no resistance to these movements other than the trifling one of its own weight has the greatest merit. It must also be self-acting.

Until the invention of Mr. Hardaker, there was great difficulty in templing heavy and broad cloths in a self-acting manner. It is of the utmost importance to have the temple roll as close to the front of the shed as possible. Sometimes the beat of the reed will move the cloth horizontally an inch or more; and if the temple is rigidly mounted, a distance exceeding this movement must be allowed between the front of the shed and the roll. When the reed recedes, the front of the shed follows it for some distance, and the cloth must also pass or rub back over the roll, and this rubbing may cause marks or other damage near the selvages. Again, to allow for a considerable vertical movement of the cloth a temple with rigid mounting must be set well back from the shed, to enable the cloth to rise and fall without damage to itself. But this necessary setting the roll back from the front of the shed is just what is not wanted, for the simple reason that it does not properly support the selvages to resist the drag of the filling or weft.

To secure proper templing it is necessary to have a mounting which will allow a roll to be placed close to the shed and move in every direction with its changes of position. In other words, the temple must rise and fall with the cloth and follow the reciprocating motion of the beat of the reed.

The original Swiss or Mathis temple, known in this country as the Kayser temple, had all the oblique pin rings and washers forming the roll, of the same diameter. This construction caused most of the work to be done by the pin ring nearest the end of the roll towards the centre, or farthest from the selvage, because this first takes the strain, and the pins were liable to leave prominent and objectionable markings on many classes of goods. To avoid this, many devices have been tried, of which the most simple and successful is tapering the roll by making the pin rings and washers of successive smaller diameters. It is obvious that the ring nearest the end, or the smallest ring, will draw least and the largest one most; this equalizes the draught of all the rings, and entirely prevents marking or tearing the cloth, and leaves an almost perfect

selvage. Our new pattern for light dress goods is made of smaller size and is giving satisfaction where it is in use.

The ingenious arrangement for sliding the head of the temple back, in case it strikes the shuttle or for any other reason, effectually prevents any damage, and is most convenient for removing the roll for examination or other purpose. The slots in the washers between the pin rings forming the roll keep the rings free from dirt or grease; therefore they never stick and seldom need renewing.

The Hardaker Patent Temple is a great advance over any temple previously made for woolen and worsted fabrics. It is readily adjustable, self-acting, not liable to damage or excessive wear, and rises and falls with the cloth and follows the reciprocating motion of the beat of the reed.

DIRECTIONS FOR APPLYING.

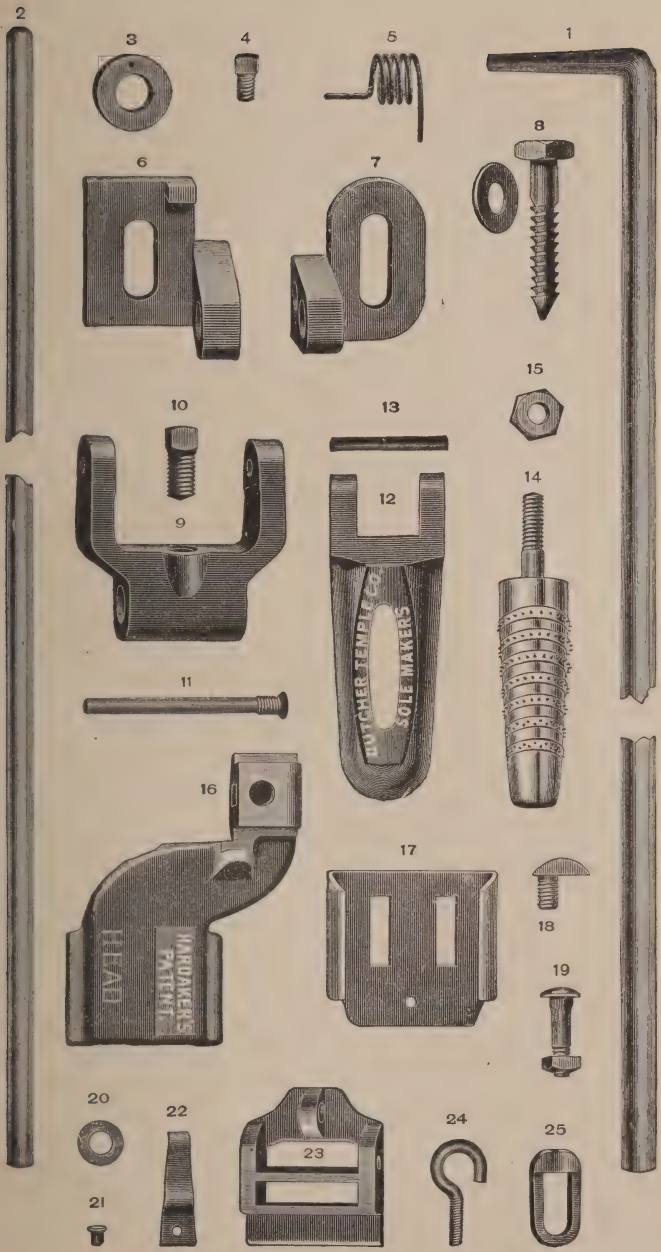
Set brackets flush with top of breast beam. End of rod with spring and collar must be at outside, and bracket set out to full width of reed. The stirrup should be set perpendicular, or leaning a little forward. The head should be set nearly level, or it may lean toward the lay to suit the kind of goods woven; it should also be set as near the reed as is safe and just above the race-board, so that it will clear the corner of the lay. The roll is adjustable in the head for giving more or less bind in the cap. The spring collar should be carefully adjusted on rod to give the temple the same length of movement that the cloth has over the breast beam. The upright pin in the spring end of the rod indicates the motion of the temple and also serves as a stop.

When weaving heavy goods with soft filling the temples should be set in three eighths of an inch at each side to avoid excessive strain. For worsted or cotton-warp goods they may be set out to the full width of the warp.

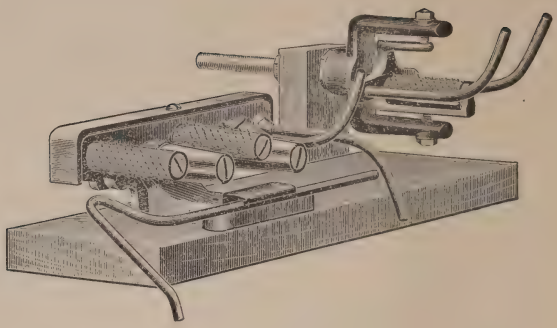
Technical Names of Parts.

1.	Large rod.	14.	Roll.
2.	Small rod.	15.	Roll nut.
3.	Collar.	*16.	Head.
4.	Collar set-screw.	17.	Head holder.
*5.	Spring for large rod.	18.	Lock-screw for top.
*6.	Outside bracket.	19.	Saddle bolt.
*7.	Inside bracket.	20.	Washer.
8.	Bracket screw and washer.	21.	Rivet.
*9.	Stirrup.	22.	Friction spring.
10.	Stirrup set-screw.	23.	Saddle.
11.	Saddle pin.	24.	Hook.
*12.	Top.	25.	Link.
13.	Top pin.		

*Parts marked with a * are made right and left.



PARTS OF HARDAKER'S PATENT TEMPLE.



HOLLINGWORTH DRYER FEED.

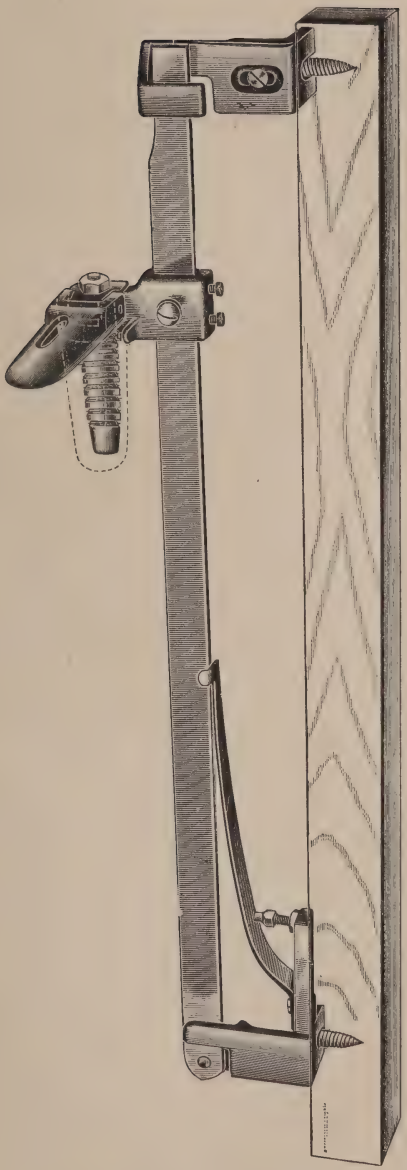
We are now introducing an automatic feed for drying machines, which has met with considerable success, the labor saving results being of high importance, amounting to 50 per cent., by disposing of one operative where two were formerly necessary. The mechanism is more or less allied to devices used in templing cloth, as temple rolls are applied to engage the selvage of the cloth in the machine. Our feed is simpler than any other on the market, containing no oscillating or driven parts, and therefore nothing to replace, or get out of order. It can be applied to any chain dryer in use, and can be used on any kind of cloth usually passed through these machines.

In order to prevent confusion, we wish to have it definitely understood that this idea is the invention of Mr. Leonard C. Hollingworth, and is an entirely different mechanism from that invented by Mr. Louis Hollingworth for the same purpose.

We sell these machines on a guarantee, so that they may be returned, if not satisfactory.

THE KNOWLES TEMPLE.

The Knowles temple is a modification of the Hardaker, especially arranged for application to the Knowles looms. It has less motion than the Hardaker, being only intended for open shed weaves.



THE KNOWLES TEMPLE.

DUTCHER PATENT "KNOWLES" TEMPLE.

TECHNICAL NAMES OF PARTS.

1. Bar.
2. Spring.
3. Swivel.
4. Inner Bracket.
5. Stop.
6. Outer Bracket.
7. Head.
8. Bracket Screw and Washer.
9. Tension Screw.
10. Head Screw.
11. Swivel Screw.
12. Top.
13. Top Pin.
14. Roll.
15. Roll Nut.
16. Spring Screw.
17. Lock Screw.

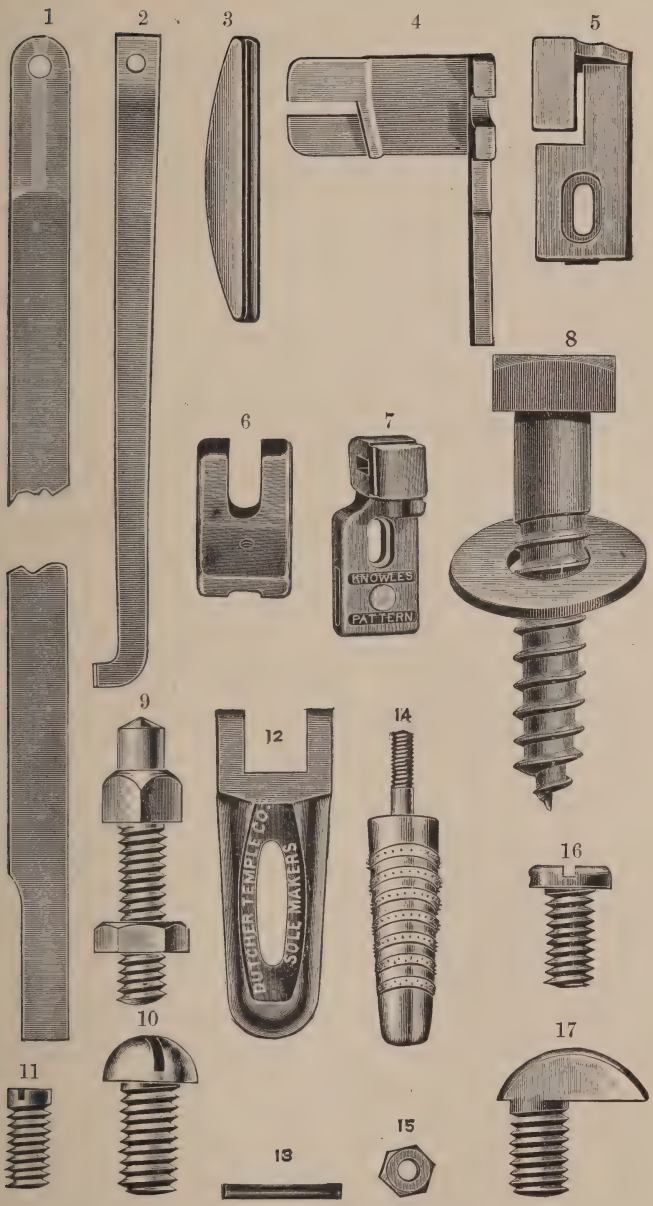
Parts 2, 4, 5, 7 and 12 are made in Rights and Lefts.

Parts 2, 4, 5, 6, 7, 12 and 14 are made in different shapes and sizes, and must be ordered by sample or by number on pattern.

The rest can be ordered by this list, as "Bar for Knowles Temple."

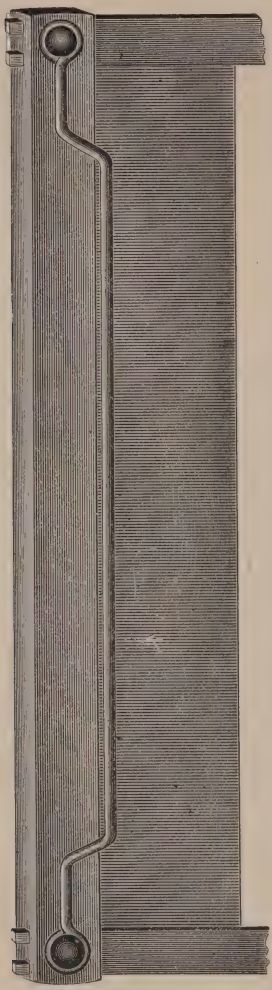
All cuts one-third size, but 8, 9, 10, 11, 15, 16 and 17.

Made with 5, 7 or 9 rings to roll as ordered.



PARTS OF KNOWLES TEMPLE.

SULLIVAN'S PATENT SHUTTLE GUARD.



These Shuttle Guards are made of the best quality coppered wire, five-sixteenths of an inch in diameter, and are long enough to reach the entire length of the hand rail. An eye is formed in each end, and these eyes fit over the bolts which attach the hand-rail to the swords. No other fastening is required, except for certain widths of looms, when a center support is added. The guard fits closely to the hand-rail for about three inches at each end and is then bent to hang over the race in any position desired.

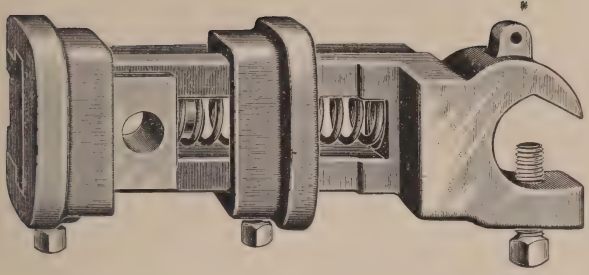
This form of construction and attachment makes the most simple and durable shuttle guard that has thus far been introduced.

The hand-rail is not cut or damaged in any way in making the attachment, nor are there any bolts, screws, or other fastening, such as have to be used with other guards, to work loose and annoy and hinder the weavers. In weaving extreme width goods on narrow looms, this guard has an advantage over others in having no bolt ends to project from back of hand-rail to tear or damage the harness.

This guard can be applied for repairs where it would otherwise be necessary to renew the hand-rail, at less than half the cost of making and fitting a new hand-rail. There are thousands of them in use.

DIRECTIONS FOR ORDERING.

Give length between centers of bolts that attach hand-rail to swords, and distance it is desired to have the guard project forward from face of hand rail and down below centers of bolts.



THE IMPROVED DURKIN THIN PLACE PREVENTER.

We applied thousands of these attachments to the old common looms before entering the loom field and since we have been building looms we have naturally neglected the improvement of competing structures. Those who wish to get the best results out of their old looms when weaving light goods can use them to great advantage. They lessen thin and thick places, lessen the results of shuttle smashes, lessen warp breakage, and increase production. We recommend them to purchasers of our Northrop Looms who intend to weave light goods on them. Every improvement that tends to lessen the breakage of warp threads is of high importance when endeavoring to increase the number of looms per operative. A slight extra cost at the start may pay for itself many times and not always receive due credit for the performance.

The construction consists of a pair of arms fastening to the usual bar across the loom which supports or forms the whip roll, and a roller held at its ends by the sliding bearings, noted in the cut by the open hole for the journal. Where Bartlett let-offs are in use the regular roll may be used without necessity for an additional warp roller.

In our first patterns there was difficulty at times in adjusting the tension of the spring to allow definite control of the movement of the whip roll. We have now overcome this trouble by using uniform spring tension and governing the movement by adjustable stops as shown. We make patterns to fit different styles of looms.

PATENTS AND PATENTEES.

In our vocation of introducing cotton machinery improvements, we have necessarily had continued connection with a wide range of inventive talent, and as many of the readers of this work are gifted with that species of ingenuity, which discovers possible chances for improvement, it may be of interest to point out certain facts and necessities in this line. At present, we are primarily interested in improvements on the devices shown in this book, and usually refer suggestion in other lines to builders of the other classes of machinery. We are always interested, however, to note any really marked and important novelty in any cotton machine line.

While an invention is primarily a *new* method of accomplishing a desired result, it is of little value unless it points out a *better* method. The only object of patenting impractical, or inferior methods, is for purposes of protecting some other invention from competition, by a possible further development that would be of value. It is often difficult for an inventor to comprehend the fact that while he may have a decidedly new idea, he cannot necessarily use the idea, if there is a patent already granted with a claim which covers his device. Pioneer patents are often broad enough to absolutely prevent competition by devices for the same purpose, no matter how they may vary in design or combination of parts. It must be remembered that the courts usually recognize the value given to the world by the first introducers of a real improvement, so that it will not do to rely too strongly on possible evasion of technical language, or clever rearrangement of parts.

No invention is proved to be of great value until it has actually accomplished its designed purpose, in an extensive, practical test. One spindle, or one loom, proves nothing, for a larger trial always develops defects which it is impossible to note in a single experiment.

Inventions in our line are usually in the direction of lowering the cost of the machine itself, lowering the cost of operation, or enabling it to turn out a greater product, or a better quality of product. The most valuable inventions are those which can accomplish all of these results; although the question of the cost of construction is usually very immaterial, if the gain in other directions is noteworthy.

No invention can be protected by a patent, if it has been in public use for two years before the application. A patent is void if granted in the name of a man who is not the real inventor, and it is also void if patented in the name of several

parties, any one of which has not contributed an essential part of the invention claimed.

We inspect hundreds of inventions every year, which are sent to us in trust, and we fail to remember any case in which an inventor has ever claimed any breach of faith. It is, of course, embarrassing when several inventors send us the same idea. This often happens, as several men may discover a mechanical defect at the same time and think out the same method of cure. A large majority of the ideas sent to us are already anticipated by granted patents. We always prefer to acquire an invention before it has been patented, as we are unwilling to trust to the ordinary methods by which patents are obtained. It is impossible for the average patent attorney to grasp all the possibilities in any single line like this, for the majority of them have never been in a cotton mill, and few, of course are educated as to the state of the art, or the detail of the necessities of operation. When we are not impressed with the patentability of an idea, we often notified the inventor that we will consider the matter if he *can get* a patent; but we fail to remember any such instance in which we were forced to change our view-point by the unexpected success of the owner under these circumstances.

The inventor must not make the mistake of considering himself entitled to all the value of his idea, unless he is willing to devote his own time and capital to its introduction. We expect to make a profit on our patent purchases, else there would be no inducement for us to continue in the business; and we must also make enough profit out of the successful inventions to pay for the many failures which are inevitable. In spite of our long experience, we probably make ten failures in trial for every successful idea introduced; and we certainly purchase at a higher rate than ten worthless patents for every one that is found to be of the slightest value.

There is an erroneous impression current, to the effect that an inventor is invariably cheated out of his rights, many people considering him as a rare and peculiar genius, to whom the world will owe a large share of its progress. If such judges could witness the steady stream of inventors to our office, and read our correspondence, they would possibly change their views; for inventors are numbered not by the hundred, but by the thousand and the tens of thousands. This talent is measured, like every other commodity, by the law of supply and demand; and no inventor is forced to sell his ideas, in this free country, if they are not valued to his liking.

Any man who notes defect in machinery under his charge, and reasons out a way to better it, should certainly endeavor to have the idea put into practical use. It is not advisable,

however, for those who are naturally expected to devote their time to some regular occupation, to devote their entire thought to possible mechanical combinations, in the hope of chancing on some salable idea. Few can afford to make invention their sole occupation, and such must be trained by a long experience and education in the work of designing and experimenting, before their continued service in this field can be of value.

The honest endeavor to improve and possibly profit by recognition of value involved is unfortunately often paralleled by an endeavor to weaken the strength of a pioneer invention by mere evasion, in the endeavor to levy tribute from the controlling element or to share in the profits developed by the newly awakened public demand. While there may be a gambler's chance for gain, the usual result is loss of time and loss of funds. With so many chances for improvement there is no excuse for waste of creative thought in mere attempt at imitation.

HOPEDALE INVENTORS.

The majority of the useful ideas adopted in our machinery are naturally of home origin. The following list gives the number of patents turned over to Hopedale interests by those who have been directly employed by our various organizations and their predecessors up to Jan. 1, 1901. Several of those named have invented before or after employment here, so the list does not necessarily show the total sum of inventions per individual. While quantity is no test of quality, it presumes a prolific creative power at least.

While several patents are included twice or more, when being of joint invention, there are 641 separate cases in the lot, representing at least $64,100, for patent fees and legal expenses, double that amount for incidental expense and litigation, and at least, ten times that amount for experiments. This estimate does not include the payments made to the inventors, either directly or indirectly, and does not include 741 more inventions acquired from outsiders by the various concerns in which we are interested. We now average to buy or apply for about two patents per week. We reject at least twice as many proffered ideas weekly on the ground of unpatentability or want of merit. We state these facts as illustrative of a

peculiar branch of business which has been developed under unique circumstances to proportions which command attention.

Allen, N. I.	13	Entwistle, T. C.	7
Allen, W. E.	7	Fay, R. C.	9
Bancroft, J. B.	14	French, C. H.	1
Bancroft, W.	6	Gifford, A. T.	2
Beardsell, A. W.	2	Gray, J. R.	9
Bigelow, M. J.	3	Keeley, J. W.	2
Bracken, H. W.	5	Knight, G. W.	9
Burgess, G. M.	1	Lawrence, H.	2
Burton, J. L.	2	Mason, E. P.	3
Carroll, W. T.	41	Northrop, J. H.	95
Chapman, N.	12	Northrop, Jonas	6
Clement, A. W.	5	Nutting, C. E.	2
Coppinger, M.	1	O'Connell, P. J.	2
Cottrell, J. D.	3	Prest, J. E.	11
Darling, E. A.	1	Rhoades, A. E.	26
Davenport, E. W.	2	Robbins, E.	3
Day, C. M.	6	Roper, C. F.	27
Dixon, W. L.	1	Sadler, W. H.	1
Draper, E. S.	3	Shorey, S. S.	1
Draper, G.	42	Stafford, A. E.	1
Draper, G. A.	11	Stimpson, E. S.	29
Draper, G. O.	77	Stimpson, W. I.	10
Draper, I.	2	Tarr, G. L.	1
Draper, W. F.	65	Thwing, A.	1
Durkin, D.	6	Wait, O. E.	2
Dutcher, F. J.	5	Walker, R.	2
Dutcher, W. W.	20	Walmsley, J.	3
Edmands, A. B.	8	Welch, W.	2
Edmands, Geo. D.	6	Whitmore, F. A.	3
Emery, A. D.	1	Wright, D.	1